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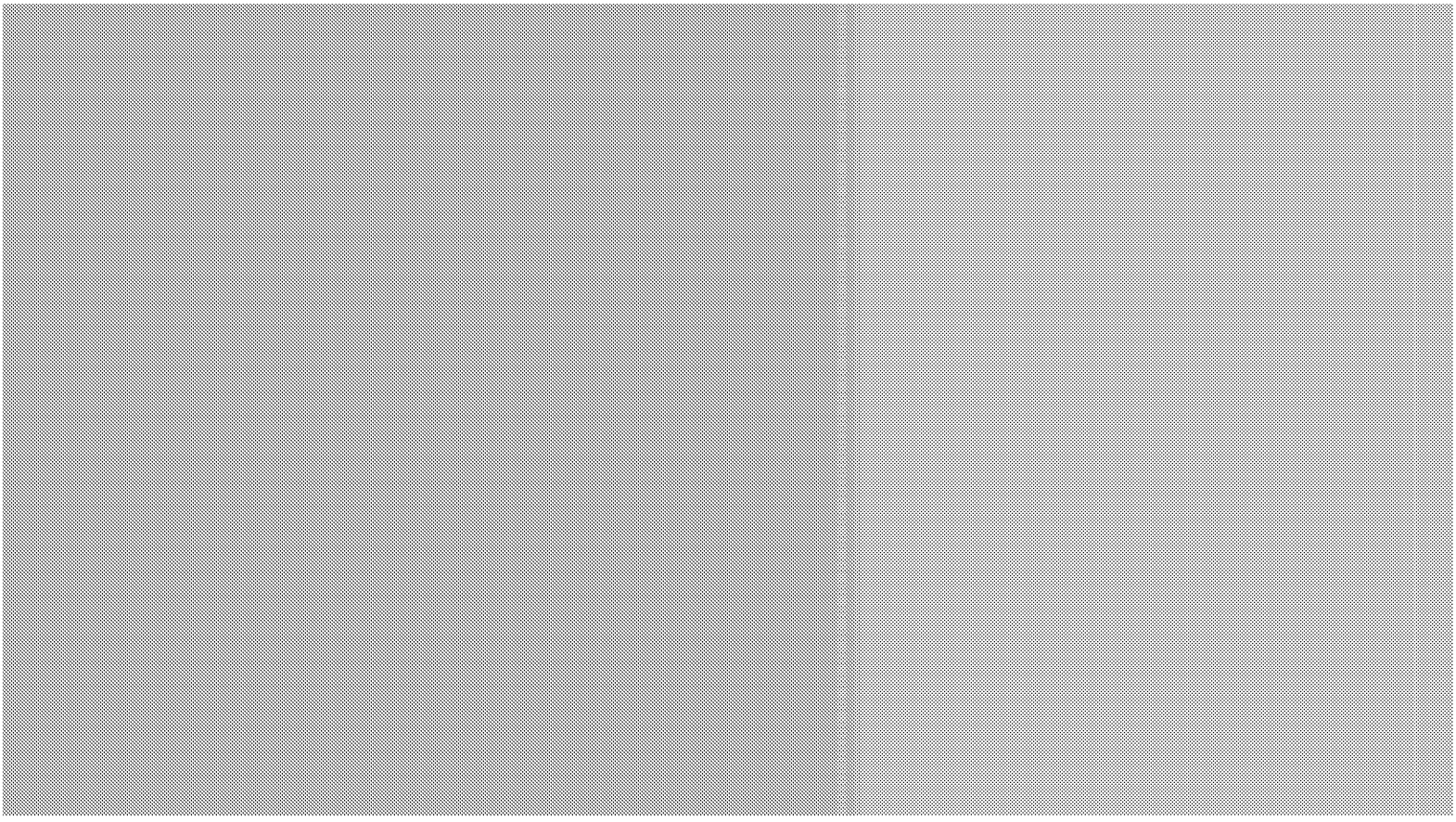
Quality Assurance Project Plan

Former Burlington Industries Cheraw Site
Docket No. 04-2017-3459

650 Chesterfield Highway
Cheraw, Chesterfield County
South Carolina



Former Burlington Industries Cheraw Site
Cheraw, South Carolina
Docket No. 04-2017-3459

Quality Assurance Project Plan
November 22, 2017

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Former Burlington Industries Cheraw Site
Cheraw, South Carolina
Docket No. 04-2017-3459

Quality Assurance Project Plan

Prepared For And Submitted To The
United States Environmental Protection Agency
Region IV
Atlanta, Georgia 30303

November 22, 2017

On Behalf Of:
Highland Industries, Inc.
Cheraw, South Carolina 29520

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ACRONYMS AND ABBREVIATIONS

AOC	Agreement and Order on Consent by Removal Action
Burlington	Burlington Industries, Inc.
CLP	Contract Laboratory Program
COCs	chemicals of concern
DQLs	Data Quality Levels
DQOs	Data Quality Objectives
ECD	electron capture detection
EDD	electronic data deliverable
EPA	Environmental Protection Agency
FSAP	Field Sampling and Analysis Plan
GC/MS	gas chromatograph/mass spectrometry
Highland	Highland Industries, Inc.
LCS	laboratory control sample
LIMS	Laboratory Information Management System
MDL	method detection limit
MS/MSD	matrix spike/matrix spike duplicate
OSC	USEPA Region 4 On-Scene Coordinator
PARCC	precision, accuracy, representativeness, comparability, and completeness
PCB	Polychlorinated Biphenyls
PQAM	Project Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QMP	Quality Management Plan
RA	Removal Action
RG	Remediation Goals
RAOs	Remedial Action Objectives
RL	reporting limit
RPD	relative percent difference
SCDHEC	South Carolina Department of Environmental Control
SOP	Standard Operating Procedures
SOPQAM	EPA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
TSA	technical surveillance audit

PREFACE

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities and specific quality assurance/quality control (QA/QC) procedures associated with the Removal Action (RA) activities related to the soils and sediments associated with the Former Burlington Industries (Burlington) Cheraw Site (Cheraw Site or Site) in Cheraw, Chesterfield County, South Carolina. This document is organized according to the Environmental Protection Agency (EPA) Requirements for Quality Assurance Project Plans (EPA QA/R-5, March 2001, reissued May 2006). Although this QAPP can be viewed as a stand alone document, it is being prepared in conjunction with and is considered a part of the Field Sampling and Analysis Plan (FSAP, AECOM November 2017) and Removal Action Work Plan (RA Work Plan, AECOM December 2017), which were prepared for the soils and sediments associated with the Cheraw Site. As activities subsequent to the RA Work Plan are performed, this QAPP will be revised and reissued as appropriate.

Specific protocols for sampling, sample handling and storage, chain-of-custody, and laboratory and field analyses will be described in this document. QA/QC procedures will be structured in accordance with applicable technical standards and U.S. EPA's requirements, regulations, guidance, and technical standards. This QAPP has been prepared in general accordance with the U.S. EPA QAPP policy as presented in EPA Requirements for Quality Assurance Project Plans (QA/R5)" EPA/240/B-01/003 (March 2001, reissued May 2006), "Guidance for Quality Assurance Project Plans (QA/G-5)" EPA/240/R- 02/009 (December 2002), and "Uniform Federal Policy for Quality Assurance Project Plans," Parts 1-3, EPA/505/B-04/900A-900C (March 2005) as cited in the Agreement and Order on Consent for Removal Action (AOC). Additional guidance used in preparing this QAPP is presented in Section 5.0.

1.0 PROJECT MANAGEMENT

1.1 TITLE PAGE AND APPROVALS

Quality Assurance Project Plan for the Removal Action Activities

_____ November 22, 2017
Felix Nchako Date
AECOM Project Manager

_____ November 22, 2017
Martha Meyers-Lee Date
AECOM QA Manager

1.2 DISTRIBUTION LIST

The individuals listed below will be provided with controlled copies of this QAPP. These persons will be provided a revised copy of the QAPP. Each individual listed below may have responsibility for distributing to other persons uncontrolled copies of this QAPP as appropriate.

Name	Affiliation
Matthew Huyser	U. S. EPA Region IV, Atlanta, GA
Judy Canova	South Carolina Department of Health and Environmental Control, Columbia, SC
Ethan Ware	Counsel for Highland, Columbia, SC
Felix Nchako	AECOM, Atlanta, GA
Martha Meyers-Lee	AECOM, Morrisville, NC
Patrick Gallagher	AECOM, Atlanta, GA
Brent Jacobs	AECOM, Atlanta, GA
Carey Bocklet	GEL Laboratories, Charleston, SC

1.3 PROJECT/TASK ORGANIZATION

Highland Industries, Inc. (Highland) contracted with AECOM to conduct RA activities related to the soils and sediments associated with the Former Burlington Industries Cheraw Site. Highland enlisted other organizations to assist them in addressing their obligations. An organization chart is presented in Figure 1. The responsibilities of key personnel are described below. Additional details concerning the organization of the Supervising Contractor are presented in the RA Work Plan.

1.3.1 Management Responsibilities

U.S. EPA Region IV On-Scene Coordinator (OSC)

Matthew Huyser is the U.S. EPA Region IV OSC. He has overall responsibility for ensuring RA activities comply with the AOC.

Highland Industries, Inc.

Ms. Cheryl Malloy of Highland Industries in Cheraw, SC serves at the Highland's Vice President of Environmental, Health and Safety and will act as project lead.

Mr. Ethan Ware of Williams Mullen located in Columbia, SC serves as the Highland's legal and administrative counsel pertaining to all environmental matters associated with the Cheraw Site.

AECOM Technical Services, Inc.

The AECOM Technical Services, Inc. (AECOM), Atlanta, Georgia office has been selected by Highland as the Supervising Contractor for the soils and sediments removal associated with the Cheraw Site. As such, AECOM is responsible for implementing the tasks necessary for Highland to comply with the AOC.

AECOM Project Manager

Felix Nchako is the AECOM Project Manager. He has overall responsibility for ensuring AECOM meets Highland's requirements relative to the RA and the AOC. Therefore, he will be concerned with:

- Communicating with Highland's representatives concerning all aspects of the project;
- Communicating with the EPA, with Highland's approval;
- Procuring subcontractors;
- Assigning duties to project staff and orienting project staff to the specific needs and requirements of the project;
- Ensuring overall RA activities are conducted in accordance with this QAPP;
- Approving project-specific procedures and internally prepared plans, drawings, and reports;
- Serving as the focus for coordination of all field and laboratory task activities communications, reports, and technical reviews, and other support functions; and,
- Ensuring compliance with the AECOM Quality Management Plan (QMP).

AECOM Project QA and Data Management Officer

Martha Meyers-Lee will serve as the QA and data management officer for this project. Her QA management responsibilities include:

- Reviewing the QAPP;
- Maintaining the official, approved QAPP and distributing controlled copies;
- Reviewing and approving QA procedures, including any modifications to existing approved procedures;

- Ensuring QA audits of the various phases of the project are conducted as required;
- Ensuring data validation/data assessment is conducted in accordance with the QAPP; and,
- Reporting on adequacy, status, and effectiveness of the QA program to the AECOM Project Manager.

As data management officer, Ms. Meyers-Lee will oversee data management and distribution for the project. She will establish and maintain the analytical database (i.e., EnviroData) for the project and will maintain the spatial data related to the project. Her data management responsibilities include:

- Coordinating with the analytical laboratory(ies) concerning electronic data deliverable (EDD) requirements, sample tracking, and schedules;
- Ensuring post-laboratory report activities are performed and their results are included in the analytical database;
- Coordinating with those collecting spatial data to ensure the appropriate level of data quality is acquired and that deliverables are in the proper format; and,
- Overall database administrator duties including coordinating the dissemination of project related data.

AECOM Field Manager

The AECOM Field Manager has overall responsibility for completion of all field activities in accordance with the associated plans including this QAPP. Mr. Brent Jacobs will serve as the Project Field Manager. However, Mr. Jacobs will not always be on site at times when AECOM personnel are performing field activities. Therefore, his designee will serve as field manager in his absence. The field manager is the local point of contact when the AECOM Project Manager is not present at the Cheraw Site, and he will serve as the liaison between the Project Manager and the field team. Specific responsibilities of the Field Manager include:

- Coordinating activities at the site;

- Assigning specific duties to field team members;
- Mobilizing and demobilizing of the field team and subcontractors to and from the site;
- Directing the activities of subcontractors on site;
- Resolving any logistical problems that could potentially hinder field activities, such as equipment malfunctions or availability, personnel conflicts, or weather dependent working conditions; and,
- Implementing field QA and QC, which includes:
    - Including issuance and tracking of measurement and test equipment;
    - Ensuring field instrumentation is calibrated according to the proper frequency;
    - Ensuring proper labeling, handling, storage, shipping, and chain-of-custody procedures are used at the time of sampling; and,
    - Controlling and collecting all field documentation.

1.3.2 Project Execution

Laboratory Analytical Program

It is anticipated GEL Laboratories LLC will perform the chemical analyses related to the project. The laboratory will also provide general support for the sample collection activities related to the project. Their responsibilities include:

- Providing the appropriate sample collection containers with preservatives appropriate for the analysis to be performed;
- Providing suitable shipping containers for the return of the filled sample containers;
- Maintaining in-laboratory sample chain-of-custody;
- Performing all activities in accordance with their internal QA/QC procedures;

- Coordinating with AECOM regarding analysis report delivery and electronic data deliverable (EDD) delivery; and,
- Communicating with AECOM concerning data quality or other issues.

AECOM Field Staff

The field staff will report to the Field Manager. The responsibilities of the field team will vary according to the task(s) to be implemented. It is anticipated their responsibilities will include:

- Collecting samples, conducting field measurements, and decontaminating equipment according to documented procedures stated in the FSAP;
- Ensuring field instruments are properly operated, calibrated, and maintained, and adequate documentation is kept for all instruments;
- Collecting required QC samples and thoroughly documenting QC sample collection,
- Ensuring field documentation and data are complete and accurate; and,
- Communicating any nonconformance or potential data quality issues to the Field Manager.

AECOM Data Validator

AECOM personnel performing data validation will communicate with the AECOM Project QA Officer. A Data Validator is responsible for validating the analytical data in accordance with the QAPP and communicating the results of the validation to the QA officer and database administrator.

1.4 PROBLEM DEFINITION AND BACKGROUND

The purpose for the activities addressed by the RA Work Plan and this QAPP are presented in the AOC. The general background and history and findings of fact for the Cheraw Site are also presented in the AOC and in the RA Work Plan. The Remedial Action Objectives (RAOs) for the impacted soils and sediments associated with the Cheraw Site are defined in the AOC and best

describe the outcome to be achieved at the Cheraw Site. In summary, the RAOs for the soils and sediments associated with the Cheraw Site are:

- Perform an assessment to delineation of surface and subsurface soil and sediments to determine the presence of PCBs above the preliminary "clean-up criteria concentration" (1 ppm) at (1) the northwestern portion of the Highland Plant, (2) Huckleberry Park, and (3) the Western Ditch and property located along the cut bank of the Western Ditch and property boundary markers; and,

- Consistent with the AOC, remediate soils and sediments by excavation, closure in place, or no disturbance of soils and sediments above the preliminary "clean-up criteria concentration" through excavation and/or dredging to a depth up-to 24 inches (2 feet).

This QAPP addresses sample collection activities, which may occur prior to, or during, the RA in order to obtain information necessary to support the RA or refine the RA Work Plan. Also, this QAPP has been developed to address RA activities when collecting samples to determine if the RAOs have been met as require by the AOC. As the RA process progresses, the need for sampling and chemical analysis can be better evaluated. Consequently, some anticipated sample collection activities may not be performed. However, the AOC requires a determination RAOs have been met. Therefore, some sample collection may be considered optional, and some may be considered mandatory. The sample collection activities addressed by this QAPP will be performed to:

- Confirm, as necessary for the RA stated in the AOC, concentrations of analytes in the soil and sediment are similar to the concentrations identified in the previous investigations at the Cheraw Site;

- More precisely define, as necessary, the extent of soil and sediment requiring removal;

- Confirm, at the conclusion of the RA, all soils and sediment within the Site exceeding clean-up levels required for removal in areas designated an "High Occupancy Area" are removed (i.e., confirmatory sampling);

- Confirm, at the conclusion of the RA, all soils and sediments within the Site remaining in place meet the clean-up levels for "Low Occupancy Area";

- Determine the proper disposal requirements for soil and sediment removed from the Cheraw Site (i.e., waste characterization); and,

- Obtain other data as necessary to support the RA activities (e.g., other waste streams from RA activities, physical properties of unimpacted soils and sediments, etc.).

1.5 TASK DESCRIPTION

1.5.1 Description of Work to be Performed

Soil and sediment samples will be collected and analyzed to delineate the extent and magnitude of surface and subsurface impacts to better define the areas requiring RA or to effectively complete the RA. General task locations for the soil and sediment sample are presented in Figures 1 and 2 of the FSAP. Additional soil and sediment samples may be collected to assess the effectiveness of the RA. Regardless, this QAPP is intended to address the collection and analysis of soil and/or sediment samples from the Highland Plant, Western Ditch, and Huckleberry Park removal action areas designated in the AOC. These samples will be analyzed for the chemicals of concern (COCs) identified in the AOC: total Polychlorinated Biphenyls (PCBs).

1.5.2 Schedule

The schedule for the RA is presented in the RA Work Plan.

1.6 QUALITY OBJECTIVES AND CRITERIA

1.6.1 Data Quality Objectives

The AOC for the site mandates development of a sampling program for soil and sediment for the Highland Plant, Western Ditch, and Huckleberry Park removal action areas designated in the AOC. This program is intended to confirm removal of the soils and sediments associated with the Former Burlington Industries Cheraw Site. Additionally, the AOC specifies sampling of sediment and soil to confirm removal of these media exceeding the Remedial Goals (RGs) in areas designated as High Occupancy Area. Other sampling addressed by this QAPP includes determination of the characteristics of the materials to be disposed of offsite, sampling to better delineate the area within

the Highland Plant, Western Ditch, and Huckleberry Park requiring RA, and other sampling to obtain data necessary for the RA.

The specific data quality objectives (DQOs) are derived from the requirements of the AOC and are as follows:

- Delineation of surface and subsurface soils and sediments within the Highland Plant, Western Ditch, and Huckleberry Park removal areas designated in the AOC above preliminary "cleanup criteria concentration" of 1 ppm for total PCBs;
- Confirmation of removal of all soils and sediments within the Highland Plant, Western Ditch, and Huckleberry Park removal areas designated in the AOC exceeding a preliminary "cleanup criteria concentration" of 25 ppm for total PCBs;
- Confirmation of removal of all soils and sediments within the Highland Plant, Western Ditch, and Huckleberry Park removal areas designated in the AOC exceeding a preliminary "cleanup criteria concentration" of 1 ppm for total PCBs, but only in the event the area is not defined as "Low Occupancy Area"; and,
- Confirmation soils and sediments left in place within the Highland Plant, Western Ditch, and Huckleberry Park removal areas designated in the AOC in areas defined as "Low Occupancy Area" have total PCB concentrations that are greater than a preliminary "cleanup criteria concentration" 1 ppm but less than 25 ppm.

1.6.2 Measurement Performance Criteria

Measurement performance criteria provide the means by which data will be evaluated to determine if the DQOs are being met. For this work, there is essentially one measurement that will be performed: chemical analysis. The chemical analysis will be evaluated based on the QA/QC criteria described in Section 4 of this QAPP. Additionally, the chemical analysis data will be evaluated for usability and limitations using a review procedure that is modeled after EPA guidance. All data, with the exception of any data qualified as rejected or any data originating from QC samples, will be used in determining if the appropriate RG has been reached.

1.6.3 Data Quality Assessment

The quality of the data produced by the analytical laboratory can be assessed to determine if the data are adequate for the purposes of the analysis. Typical analyses performed using common EPA or other standard protocols are assessed by comparison of the results of QC analyses with established acceptable limits for precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS).

1.6.3.1 Precision

Precision is a measure of the degree to which two or more measurements of the same item are in agreement. Precision can be thought of as the amount of variability in the analysis results for the same sample. The formal definition is the measure of the variability of a group of data compared to their average value. Precision can be quantified by calculating the relative percent difference (RPD) of the results for a pair of duplicate samples according to the formula:

$$RPD = \frac{(R_1 - R_2) \times 100}{R_{Bar}} \quad \text{or} \quad RPD = \frac{(S_1 - S_2) \times 100}{S_{Bar}}$$

where:
R_1 and R_2 are the first and duplicate results, respectively
R Bar is the average of the two duplicate results
S_1 and S_2 are the spike and duplicate spike results, respectively
S_{Bar} is the average of the two duplicate spike results.

Field precision is assessed through the collection of duplicate samples that are submitted blind to the analytical laboratory (i.e., the laboratory is unaware of that the samples are duplicates). The RPD is then calculated after the receipt of the laboratory report. The acceptable maximum RPD is 50% for solid (i.e., sediment or soil) samples with sample concentrations greater than five times the reporting limit (RL). For those samples with concentrations less than or equal to five times the RL, precision will be evaluated based on the absolute difference between duplicate results. The laboratory will also assess precision through matrix spike and matrix spike duplicate (MS/MSD) analyses. The required level of precision for laboratory QC samples is provided in Table 1.

1.6.3.2 Accuracy

Accuracy is a measure of the how close an analysis result is to the true value. Accuracy can be determined by analyzing samples of a known concentration (commonly referred to as laboratory control samples or LCS) obtained from a commercial supplier. Adding known concentrations of surrogate compounds and matrix spike compounds to samples collected at the site and determining the percent recovery is also a measure of accuracy. The measurement for accuracy is typically expressed as the percent recovery. The formula for the matrix spike percent recovery calculation is:

$$\%\,\text{Recovery} = \frac{(Rs - Ru)}{S} \times 100$$

where: Rs – Result of the spiked sample analysis
Ru – Result of the unspiked sample analysis
S – Spike concentration

When determining the percent recovery for surrogate spikes or LCS, there is no "unspiked" sample analysis (i.e., "Ru" in the previous equation = 0). Therefore, the calculation becomes:

$$\%\,\text{Recovery} = \frac{Rs}{S} \times 100$$

where: Rs – Result of the spiked sample or LCS analysis
S – Spike or known LCS concentration

Analytical accuracy requirements are presented in Table 1.

1.6.3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. However, representativeness can be evaluated on two levels.

The first level of representativeness can apply to individual samples and the sample collection procedure. Representativeness in this case can be affected by cleanliness of sampling equipment and sample containers, exclusion of extraneous materials, effective homogenization procedures, etc. Representativeness at the sample collection level can be addressed through proper and

appropriate sample collection procedures, effective decontamination procedures, appropriately cleaned sample containers, etc.

The second level of representativeness is on the scale of the overall sampling program design. The spacing of the samples should correspond to the variability of the analytes in the media of interest. If no prior information is available concerning the variability, it may be necessary to adjust the sample locations after initial results are received. Since extensive previous SCDHEC sampling data are available for the Cheraw Site, the sampling program has been designed considering this data. The overall representativeness criterion is best satisfied by making certain that sampling locations are selected properly and a sufficient number of samples are collected.

1.6.3.4 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under perfect conditions. The formula for calculating completeness is presented below.

$$\%\ \text{Completeness} = \frac{\#\ \text{of Valid Results}}{\#\ \text{of Planned Results}} \times 100$$

For completeness requirements, valid results are all results not qualified with an "R" flag during the data validation process. Under perfect conditions, 100% of the planned samples would be collected and successfully analyzed. However, regardless of the QA/QC procedures implemented, 100% completeness is uncommon. Therefore, the completeness goal for this work is 90% based on the planned samples for each sample matrix and each analytical method.

1.6.3.5 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared with another. Sample data should be comparable with other measurement data for similar samples and sample conditions. This goal is achieved by using standard techniques to collect and analyze representative samples and reporting analytical results in appropriate units. Comparability is limited to the other PARCC parameters because data sets can only be compared with confidence when precision and accuracy are known.

1.6.3.6 Sensitivity

In addition to the PARCC criteria in assessing data quality, the usability of the data is also dependent on the sensitivity of the analytical methods and instrumentation. Sensitivity of analytical data is demonstrated by reporting limits (RLs). The target RLs for the compounds to be analyzed are presented in Table 1. These target RLs were selected in part by consideration of the data quality levels (DQLs) to be achieved (i.e., the RGs) and in part by consideration of the actual ability of the laboratory to attain RLs at the DQLs and the cost-effectiveness of implementing additional, more sensitive methods during the RA. To maximize the usability of the data, any detected compounds below the RL and above the method detection limit (MDL) will be reported by the laboratory as estimated ("J") values. This approach allows use of data where the presence of the analyte is reasonably certain, but the actual concentration of the analyte could differ slightly from the reported concentration.

1.7 SPECIAL TRAINING/CERTIFICATION

This investigation will employ routine field sampling techniques, field analyses, laboratory analyses, and data validation. Specialized training beyond what is considered typical for the personnel in the environmental industry will not be required. However, prior to starting work, personnel will be given instruction specific to the project, covering the following areas:

- Organization and lines of communication and authority;
- Overview of the RA Work Plan;
- QA/QC requirements;
- Documentation and document management requirements; and,
- Health and safety requirements.

Instructions will be provided to project personnel by the AECOM Project Manager, Field Manager, and/or Project QA Officer or their respective designees.

Laboratories utilized for routine chemical testing of soil and sediment will be certified by the State of South Carolina to perform the analysis.

1.8 DOCUMENTS AND RECORDS

This QAPP and any other controlled documents created during this project will be distributed to the personnel specified in Section 1.2 of this document. These select personnel will be responsible for tracking any uncontrolled copies created from their controlled copy. Any updates to controlled copies will be distributed to the select personnel in either hard copy or electronic format. Any changes of particular importance will be communicated to all project personnel via email, telephone, or in person, and uncontrolled copies of the affected document will be made available.

The current revision number and revision date of each controlled document will be recorded on the title page of the document and in the footer of each page in the document. For this QAPP, a revisions summary will be maintained in a tabular format following the title page. The summary will include a brief description of the revisions and the reason for the revisions.

In addition to controlled documents that will be produced during the course of this project, additional documents and records will be maintained in order to create a repository of information that supports all decisions made and conclusions presented. These documents and records can be divided into three general types: project management records and field records, laboratory records, and data validation and audit records. These types are discussed in the following sections.

1.8.1 Project Management and Field Records

The project files will be the central repository for all documents related to the performance of the RA for the soils and sediments at the Site. AECOM will maintain paper copies of appropriate materials for the RA in the project files, which will be located in a secured, limited access area of the AECOM Atlanta office. Project personnel may retain project related materials at a location other than the project files; however, they will be responsible for ensuring that the "official" copies of appropriate items are forwarded to the project files for maintenance according to the document retention schedule. The project manager is responsible for ensuring that the project file is maintained appropriately.

A project file index will be prepared that establishes the categories for organization of the project files. Information that will be stored in the project files will include items such as:

- Field logbooks;
- Field data and sample collection logs;
- Photographs, maps, and drawings;
- Calculations and notes;
- Laboratory data deliverables;
- Data validation reports;
- Correspondence with agencies and other parties;
- Meeting histories, presentations, and related materials;
- Progress reports, QA reports, interim project reports, etc.; and,
- All custody documentation (tags, forms, air bills, etc.).

Records will be retained according to the requirements of the AOC.

1.8.2 Laboratory Records

Any laboratory contracted to provide analytical support for this project is responsible for maintaining records documenting all aspects of their processes and procedures related to samples from this Site. These records and documents support the legal defensibility of the data reported. All information related to analysis will be documented in controlled laboratory logbooks, instrument printouts, or other approved forms. All entries not generated by an automated data system will be made neatly and legibly in permanent, waterproof ink. Information will not be erased or obliterated. Corrections will be made by drawing a single line through the error and entering the correct information adjacent to that crossed out. All changes will be initialed, dated, and, if appropriate, accompanied by a brief explanation. Unused pages or portions of pages will

be crossed out to prevent future data entry. Analytical laboratory records will be reviewed by the supervisory personnel on a regular basis and by the Laboratory QA Coordinator periodically, to verify adherence to documentation requirements.

The laboratory will provide one copy of the data in an electronic format. The EDD will be provided in an agreed upon format, and may be accessed through the laboratory's web-based data delivery system, if available. The hard copy data package for samples will be equivalent to a Contract Laboratory Program (CLP) deliverable, i.e., consisting of all the information presented in a CLP package, including CLP-like summary forms and raw data.

The laboratory report contents are summarized below:

- Date of report preparation;
- Chain-of-custody record with associated air bill, as applicable;
- Laboratory sample receipt documentation;
- Case narrative (It should include a detailed description of all problems encountered in the analysis and a discussion of possible reasons for any QA/QC criteria outside acceptance limits.);
- Summary of Analytical Results, including:
    - Cross reference of field sample IDs and laboratory IDs;
    - Date of sample collection, preparation, analysis, and laboratory receipt
    - Sample matrix;
    - Dates of and methods of preparation and analysis;
    - Weight or volume of sample used for preparation and analysis;
    - Dilution or concentration factor for the samples;
    - Definition of all data qualifiers and acronyms;

- Sample results, including reporting units and any laboratory applied data qualifiers;
- MDLs and RLs, adjusted for sample preparation activities;
- Analytical results (from primary and secondary);
- Unit of measure;

- Summary of QC Results, including:
  - Laboratory blank results
  - Surrogate recoveries and control limits
  - LCS results with percent recoveries and control limits
  - Laboratory duplicate results with RPD and control limits (if applicable)
  - MS and MSD results, recoveries, RPD, and control limits
  - Gas chromatograph/mass spectrometer (GC/MS) tuning results, if used for PCB sample confirmation;
  - Calibration results with control limits

- Raw data, including:
  - Sample preparation logs, including cleanup information;
  - Run logs;
  - Raw data for samples and associated laboratory QC samples, including labeled and dated chromatograms/spectra.

For each QC measurement, the theoretical value, the quality objective, and the calculated error (in terms of the quality objective for the measurement) must be maintained in a permanent record. It must be clear from the QC data report that the correct QC measurements have been made for the

method employed and what the outcome was. Relevant QC measurement data must be reported with the results for each sample.

Laboratory reports received from the analytical laboratory will be filed in the primary project file maintained by the project manager after completion of the data validation. EDDs will be managed by the project's database administrator.

1.8.3 Data Validation and Audit Records

Project personnel who are assigned to data validation tasks will be responsible for documenting the results of their validation. These reviews will be documented using a simple form (checklist), which states the validation criteria for the data being reviewed and provides a means of documenting whether the data meet the criteria. The form will also indicate whether additional data quality flags should be assigned to the data. Completed validation checklists will be forwarded to the project QA officer or designee for review and confirmation. The validation checklists will then be forwarded to the project database administrator so flags can be assigned as appropriate and the associated data can be marked as having been validated. After updating the database, the data validation will be forwarded to the project manager for inclusion in the project file with the laboratory report.

The project QA officer or designee may perform audits or assessments of the project activities to ensure that the requirements of this plan are implemented. Additionally, these audits or assessments may be performed to ensure that field activities are conducted in general accordance with the EPA Region IV *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*. The audit and assessment findings will be documented in a report to the Project Manager and a copy placed in the project file. Any corrective actions that are necessary will be documented and implemented. This QAPP will be modified if appropriate to ensure that the best quality data are collected. The effectiveness of corrective actions will also be documented in the project QA file as appropriate.

2.0 DATA GENERATION AND ACQUISITION

2.1 SAMPLING PROCESS DESIGN

The rationale for sample design is provided in the FSAP.

2.2 SAMPLING METHODS

2.2.1 Field Measurements

Surface water field measurements may be taken in conjunction with sediment sampling. Measurement of surface water quality parameters will be performed as described in FSAP.

2.2.2 Sampling Procedures

During implementation of the RA, surface and subsurface soil and sediment associated with the Cheraw Site may be sampled. Sampling will be conducted in accordance with the procedures described in the FSAP.

2.2.3 QC Sample Collection

Field QC samples will include equipment blanks and field duplicates. Additional sample volume will be collected so that the laboratory may conduct MS and MSD analyses. These samples will be collected as described below:

- Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks will be prepared by pouring laboratory grade and organic free water (provided by the laboratory) through or over non-dedicated sampling equipment after equipment decontamination and before field sample collection. Equipment blanks will be collected for all soil and sediment samples collected with non-dedicated equipment at a frequency of one per week per media sampled. Equipment blanks will be analyzed for the same parameters as their associated samples.

- A field duplicate sample is a second sample collected at the same location as the original sample. Field duplicates will be collected at a frequency of one field duplicate for every

20 or less investigative samples. Field duplicates will be collected by alternately filling two sets of identical sample containers from the interim container used to collect the sample. Field duplicate samples will be analyzed for the same parameters as their associated parent sample.

- An MS and MSD is an aliquot of sample spiked with known concentrations of Aroclors 1016 and 1260. The spiking occurs prior to sample preparation and analysis. Each analyte in the MS and MSD should be spiked at a level less than or equal to the midpoint of the calibration curve. The MS and MSD results are used to document potential matrix effects associated with a site. MS and MSD analyses will be conducted at a frequency of 5% of all investigative samples collected for the RA. For those samples designated as MS/MSDs, sufficient additional sample volume (based on the individual laboratory's requirements) will be collected.

2.2.4 Equipment Decontamination

Decontamination of equipment in the field is described in the FSAP.

2.3 SAMPLE HANDLING AND CUSTODY

2.3.1 Sample Containers, Preservation, and Holding Times

Sample containers will be provided by the laboratory. The containers will be cleaned by the manufacturer to meet or exceed analyte specifications established in the latest U.S. EPA's Specifications and Guidance for Contaminant-Free Sample Containers. Certificates of analysis will be provided with each lot of containers and maintained on file to document conformance to EPA specifications.

A summary of sample container, preservation, and holding time requirements is presented in Table 2.

2.3.2 Sample Labeling

Immediately upon collection, each sample will be labeled with an adhesive label. Samples will be assigned sample identifications as described in the FSAP and as summarized below.

Sample Media Code: A two- to three-letter alphabetic code will identify the sample media:

- SS – soil sample
- CSS – confirmation soil sample
- SD – sediment sample
- CSD – confirmation sediment sample
- WC – waste characterization sample (stockpiled soil or sediment wastes)

Sample Sequence/Location Code: A one to six-digit alphanumeric code (e.g., 1, A2, 44, RR03, SB1802, etc.) is entered following the sample media code to identify sample sequence or dedicated sampling station.

Date Code: A six digit date code is entered following the sample sequence or dedicated sampling station code. The date code will be enclosed in parentheses. For example, if the sample is collected on November 3, 2017, the date code would be (110317).

Sample Depth Code: A two character alpha-numeric code beginning with the letter "D" to indicate a specific sample depth in feet:

- D0 – surface sample
- D1 – 1 foot (ft.) below surface
- D2 – 2 ft. below surface, etc.

The depth for confirmation samples will be the actual final excavation depth from which confirmation samples are collected following media excavation/removal. For example, if two feet of soils are excavated and a confirmation soil sample (CSS) is collected from the bottom of excavation exposed soils following soil removal, the depth code would be D2 (final depth sample). No depth code will be used for waste characterization (WC) samples or equipment blanks (EB).

QA/QC Sample Code: A two- to three-letter alphabetic code to identify QA/QC samples only:

- FD – field duplicate sample
- SP – split sample
- MS – matrix spike
- MSD – matrix spike duplicate
- EB – equipment blank

No QA/QC code is warranted when samples are collected for routine analysis only and not analyzed for QA/QC purposes.

Following are examples of the sample nomenclature methodology:

SS-IA22(121417)D1 Soil sample (SS) collected December 14, 2017 (121417) from location IA22 (IA22) from a depth of 1 ft. below ground surface (D1).

SD-WMP5(121217)D0 Sediment sample (SD) collected on December 12, 2017 (121217) from sample station WMP5 (WMP5) from the sediment surface (D0).

SD-SB17(110117)D0-SP QA/QC split (SP) sediment sample (SD) collected on November 1, 2017 (110117) from sample station SB17 (SB17) from the sediment surface (D0)

SD-3(060318)EB Third (3) QA/QC equipment blank (EB) associated with equipment used to collect sediment (SD) samples on June 3, 2018 (060318).

The process for completing the sample label is presented in detail in the FSAP. In summary, the label will be completed using waterproof ink and will contain the following information:

- Client – Job Name/Project Number,
- Sample identification,
- Date and time collected,
- Sampler's signature or initials

- Preservatives added, and
- Analysis to be performed.

After the sample container is filled, it will be placed in a cooler along with wet ice to reduce the temperature of the sample to at or below 6 degrees Centigrade (°C) as soon as possible. Sample custody procedures are presented in the next section. The following information will also be recorded in a bound field log book or on a designated sample collection form at the time of sample collection:

- Sample identification;
- Date and time of collection;
- Personnel present;
- Type of sample;
- Analysis required;
- Sample location and depth (if applicable);
- Containers filled; and,
- Preservatives used.

2.3.3 Custody Procedures

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in two parts: field sample collection and laboratory analysis.

2.3.3.1 Field Sample Custody

Chain-of-custody forms will accompany samples containers to document the transfer of possession of the containers from originating laboratory or supplier, through field collection, and to the

laboratory receiving the samples for analysis. A sample container is considered to be in a person's possession when:

- It is in the persons actual possession;
- It is in the persons view, after being in their possession;
- It was secured by the person in such a way as to prevent unauthorized access (e.g., in a closed, sealed cooler); or,
- It was placed in a secure location (e.g., in a closed cooler inside a locked vehicle/trailer).

Each time sample possession changes, the appropriate section of the chain-of-custody form will be completed. The person relinquishing custody will sign and record the date and time custody was transferred to another person. The person receiving custody will also sign and record the date and time custody was received. When transferring custody to a shipping company, the chain-of-custody form will be completed and signed by the person relinquishing custody. The shipping company will be designated as the custody recipient, but no signature will be required. The chain-of-custody form will be placed inside the shipping container.

Sampling personnel will complete and verify the chain-of-custody forms. A copy of the chain-of-custody form will be retained and placed in the project file. The original form will accompany the samples to the laboratory. Each shipping container will be secured with the completed chain-of-custody form inside. The shipping container will be closed and secured with appropriate shipping tape. A custody seal will be affixed across the opening of the container such that the container cannot be opened without damaging the seal. The seal will be labeled with the date and signature of the sampler or the shipper.

Samples will be hand delivered or transported to the analytical laboratory via overnight courier, authorized laboratory courier, or field staff. . Copies of shipping documentation will be retained as part of the project file documentation. Samples will be shipped or transported to the laboratory in a timely manner. Also, when possible, samples will be shipped on the same day that they are collected.

2.3.3.2 Laboratory Sample Custody

Samples received at the laboratory will be logged in by a designated sample custodian or his/her designee. Upon sample receipt, the sample custodian will:

- Examine the shipping containers to verify that the custody tape/seal is intact;
- Examine all sample containers for damage;
- Determine if the temperature required for the requested testing program has been maintained during shipment and document the temperature on the chain-of-custody form;
- Compare samples received against those listed on the chain-of-custody;
- Verify that sample holding times have not been exceeded;
- Examine all shipping records for accuracy and completeness;
- Determine sample pH (if applicable) and record on chain-of-custody;
- Sign and date the chain-of-custody immediately (if shipment is accepted) and attach the waybill;
- Note any problems associated with the coolers and/or samples on the cooler receipt form and notify the Laboratory Project Manager, who will be responsible for contacting the AECOM QA officer or designee (client);
- Attach laboratory sample container labels with unique laboratory identification and test; and,
- Place the samples in the proper laboratory storage.

Following receipt by the laboratory, the samples will be entered into the laboratory information management system (LIMS). At a minimum, the following information will be entered in the LIMS: project name or identification, unique sample ID numbers (both field and laboratory),

sample matrix, sample type (normal versus QC), required tests, and date and time of laboratory sample receipt.

The appropriate laboratory personnel will be notified of sample arrival. The completed chain-of-custody, waybills, and any additional documentation will be placed in the project file. Specific details of laboratory custody procedures for sample receiving, sample identification, sample control, and record retention are described in the laboratory quality assurance manual and standard operating procedures (SOPs) included in Appendices A and B, respectively.

2.4 ANALYTICAL METHODS

Soil and sediment samples collected during the program will be analyzed by a qualified laboratory. The analytical methods to be used are summarized in Table 3. Target analytes and laboratory reporting limits are provided in Table 1. The laboratory turnaround time of the deliverable for PCB analyses will be two weeks from sample receipt.

2.5 QUALITY CONTROL

2.5.1 Field

QC measurements for field measurements will be limited to the calibrations described in Section 2.7. Field QC samples will be collected during soil and sediment sampling to assess the accuracy and precision of the data. These samples will include field duplicates and equipment blanks. Additional sample volume will also be collected so that MS and MSD analyses may be conducted by the laboratory. The collection of QC samples is described in Section 2.2. Frequency of collection and acceptance criteria is described in Section 2.2.3.

2.5.2 Laboratory

The selected laboratory will have a QC program in place to ensure the reliability and validity of the analysis performed at the laboratory. All analytical procedures are documented in writing as SOPs and each SOP includes the minimum requirements for the procedure. The internal QC checks differ slightly for each individual procedure but in general the QC requirements include the following:

- Blanks (method, reagent/preparation, instrument);
- MS and MSDs;
- Surrogate spikes;
- Laboratory duplicates;
- LCSs;
- Second column confirmations (GC/Electron Capture Detection (ECD) analysis);

2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

The field equipment for this project may include photo ionization detector (PID) for health and safety monitoring and water quality meter (turbidity, pH, etc.) for field measurements of surface water to be taken prior to collection of sediment samples.

The Field Manager is responsible for oversight of testing, inspection, and maintenance of field instrumentation. The field analyst/staff is responsible for conducting the field instrumentation testing, inspection, and maintenance, and the name of the field analyst/staff and results with will be recorded in the field notebook. Equipment testing, inspection, and preventative maintenance procedures to be followed for field equipment will be in accordance with SOPQAM. Where appropriate, new batteries and other spare parts will be purchased and kept with the field equipment to facilitate immediate replacement. Any deficiencies in testing, inspection, or calibration of field measurement equipment will be reported by field staff/analyst to the Field Manager, who will notify the PM and QA Officer. Corrective actions and its effectiveness will be documented by the Field Manager.

As part of the laboratory's Quality Manual, a routine preventative maintenance program will be conducted by the laboratory to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory employees will regularly perform routine scheduled maintenance and repair of (or coordinate with the vendor for the repair of) all instruments. All laboratory instruments will be maintained in accordance with manufacturer's specifications. The preventive maintenance program should include:

- An inventory of replacement and spare parts for instruments that require maintenance.
- Maintenance logbooks for each instrument with information on routine and non-routine procedures. The logbook records will include the instrument number, description of malfunction or problem, date of maintenance activity, the type of activity performed, and final resolution.
- Training of laboratory staff in the maintenance requirements of the instruments. Preventive maintenance schedules and activities will be outlined in the laboratory SOPs.

2.7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

The field instrumentation may include water quality meters (e.g., pH, temperature, conductivity, etc.) and other measurement equipment to evaluate in-situ surface water or groundwater quality parameters, if encountered. Calibration of these instruments will be performed according to the manufacturer's instructions and will be consistent with the procedures and frequencies specified in Section 16 and Section 17 of the SOPQAM, where applicable. A summary of calibration procedures and frequencies for field instrumentation is provided as Table 4. All calibration procedures will be documented in the field records. Calibration records will include the date/time of calibration, name of the person performing the calibration, reference standard used, and the results of the calibration.

Analytical instruments will be calibrated in accordance with laboratory SOPs, which are provided in Appendix B. All analytes reported will be present in the initial and continuing calibrations, and these calibrations will meet the acceptance criteria specified in this Section and laboratory SOPs.

Results outside the calibration range are unsuitable for quantitative work and will only give an estimate of the true concentration. Records of standard preparation and instrument calibration will be maintained. Records will unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards will be traceable to standard materials. All calibration criteria will satisfy SW-846 requirements at a minimum. Multipoint calibrations will contain the minimum number of calibration points specified in the method with all points used for the calibration being contiguous. The only exception to this rule is that a

standard that has been statistically determined as being an outlier can be dropped from the calibration, providing any method requirement for a minimum number of standards is met.

Other laboratory equipment such as refrigerators, balances, and ovens required for the storage and preparation of samples will be calibrated and/or monitored according to the following guidelines:

- Equipment will be checked daily and these records kept in a logbook or calibration specific log
- The laboratory will document clearly the acceptance criteria for all such equipment (e.g., refrigerator temperature) and corrective actions will be taken for any out-of-control situation as described in the laboratory's Quality Manual
- The equipment will not be used after corrective action until it has been recalibrated or verified through the successful analysis of a check standard
- Calibrations of other miscellaneous analytical equipment (e.g., automatic pipettes) will be performed according to manufacturer's recommendations

2.8 INSPECTION/ACCEPTANCE REQUIREMENTS OF SUPPLIES AND CONSUMABLES

Critical Supplies and Consumables	Inspection Requirements and Acceptance Criteria	Responsible Individual
Sample bottles	Visually inspected upon receipt for cracks, breakage, and cleanliness. Must be accompanied by certificate of analysis.	Field Manager
Chemicals and reagents	Visually inspected for proper labeling, expiration dates, appropriate grade	Field Manager
Field measurement equipment	Functional checks to ensure proper calibration and operating capacity	Field Manager
Field test kits	Inspected for proper labeling, appropriate levels of calibration standards, expiration dates	Field Manager
Sampling equipment	Visually inspected for obvious defects, damage, and contamination	Field Manager

Supplies and consumables not meeting acceptance criteria will necessitate the appropriate corrective action. Corrective measures may include repair or replacement of measurement equipment, and/or notification of vendor and subsequent replacement of defective or inappropriate materials. All actions will be documented in the project files.

The laboratory system of inspection and acceptance of supplies and consumable is documented in the laboratory QA Manual.

2.9 NON-DIRECT MEASUREMENTS

The use of non-direct data (historical reports, maps, literature searches, previously collected analytical data) will be limited to the design of the sampling program. Sampling data from previous SCDHEC investigations will be used for characterization purposes, as warranted. The data necessary to meet the objectives specified in Section 1.6 of this QAPP will be generated during the RA and will come from the following sources:

- Field records (sample locations, sample observations);

- Field measurements (geophysical surveys, water quality measurements); and
- Analytical results for chemical testing of soils and sediment.
- Site survey.

The data collected under this QAPP has been designed to be of sufficient quality to meet the program objectives.

2.10 DATA MANAGEMENT

Data management requirements are an essential part of every investigation. Data management ensures that procedures are in place to document, track, and manage all field and laboratory data generated during the course of field activities. Records management is discussed in Section 1.8 of this plan. The AECOM PM has overall responsibility for data management. The PM ensures that all field and laboratory information are collected and accurately recorded, and that inspections relating to the generation, collection, and storage of data are conducted.

Electronic data deliverables (EDDs) will also be required for the project database. Two EDDs will be required for the project. One EDD will be formatted in Microsoft Excel for the EnviroData program (version 1.6 data transfer standard), and should include both field and laboratory QC (i.e., method blank, LCS, MS, MSD, and surrogate) results. The second EDD is a field sample result cross-tabular summary that is formatted in Microsoft Excel. The electronic data will be imported into the Microsoft Access database concurrent with the data validation process. Data qualifiers generated during data validation may also be entered manually into the database. Data collected in the field will not be entered into the system, but will be filed in the project files to allow retrieval as necessary.

As data is loaded into the system, a variety of quality checks are performed to ensure data integrity. Records of the checks are maintained on file. These checks include:

- Audits to ensure that the laboratory reported results for all requested sample analyses;
- Checks that all analytes are consistently and correctly identified;

- Reviews to ensure that units of measurement are provided and are consistent;
- Queries to determine that any codes used in the database are documented properly;
- Reports to review sample definitions (depths, dates, locations); and,
- Reports to review groupings of sampling locations and coordinate systems.

Once all data quality checks are performed, the data will be final and will be available as necessary to meet project needs. Exporting of the data from the database to other formats will be minimized as much as possible to ensure that work products come from the single source of data that is known to be correct. Cross-tab tables showing concentrations by sample location can be prepared. Statistical analyses will be performed as required. Data can be accessed by a variety of mapping and visualization tools.

The project database will be maintained on a secure network drive which is backed up regularly. Access to the database will be limited to authorized users. The data will be retained in accordance with the requirements stated in Section 1.8 of this QAPP.

3.0 ASSESSMENT/OVERSIGHT

3.1 ASSESSMENT AND RESPONSE ACTIONS

This section presents planned assessments, corrective action, QA management reports, verification and validation requirements and procedures, and discussion on data assessment and usability/reconciliation.

The purpose of this section is to indicate the methods by which it will be ensured that the data collected for the RA activities fall in line with the DQOs as described in Section 1.6. To meet these DQOs, a combination of statistical procedures and qualitative evaluations will be used to check the quality of the data. These procedures will be used by the laboratory while generating the data.

Results for QC samples, including field and laboratory blanks, spikes, and duplicates, will be evaluated using the equations in the validation guidelines to determine the validity and usability of the data. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, contamination during sampling, contamination in the laboratory, and sample preservation and storage anomalies (i.e. sample holding time or analytical instrument problems).

An internal audit of field activities, including sampling and field observations, may be conducted by the AECOM Project QA Officer (or designee) early in the sampling event to verify that all established procedures are being followed.

Technical staff and field project personnel will be responsible for reporting all suspected technical or QA nonconformance or suspected deficiencies of any field collection or observation activity by recording in field notes and reporting the situation to the AECOM PM or designee. If it is determined that the situation warrants a reportable nonconformance requiring corrective action, then a nonconformance report will be initiated.

The AECOM Project QA Officer will be responsible for ensuring that the corrective action for nonconformance is initiated by:

- Stop-Work authorizations, if warranted

- Evaluating all reported nonconformances
- Controlling additional work on nonconforming items
- Determining disposition or action to be taken
- Maintaining a log of nonconformances
- Reviewing nonconformance reports and corrective actions taken
- Ensuring nonconformance reports are included in the final site documentation in project files.

Corrective actions will be implemented and documented in the field record book. Documentation of corrective actions will include:

- A description of the circumstances that initiated the corrective action
- The action taken in response
- The final resolution
- Any necessary approvals.

No staff member will initiate a corrective action without prior communication of findings through the proper channels.

Any corrective actions resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The AECOM Project QA Officer or designee will identify deficiencies and recommend corrective action to the AECOM PM. Implementation of field audit corrective actions will be performed by the Field Task Leader and field team.

If appropriate, the AECOM PM will ensure that no additional work that is dependent on the nonconforming activity is performed until the corrective actions are completed.

If a corrective action warrants a change in the program protocols, the change will be documented and signed by the Field Task Leader and AECOM PM (or designee).

3.1.1 Assessments

The types of planned assessments pertinent to this program include technical surveillance audits (TSAs) of field and laboratory activities, data package audits, and data validation audits.

3.1.1.1 Field Activity TSA

A TSA of field activities may be conducted by the Project QA Officer or his/her designate. Ideally, this audit will be conducted at the beginning of the sampling program to ensure that the approved procedures documented in the FSAP and QAPP are being followed. The TSA will include examination of field sampling records, field measurement results, field instrument operating and calibration records, sample collection, handling, and packaging procedures, QA procedures, chain-of-custody, sample documentation, etc. If significant deficiencies are noted, follow-up audits will be conducted.

During the audit, the auditor will keep detailed notes of audit findings. Preliminary results of the audit will be reviewed with the Field Manager while on site to ensure that deficiencies adversely affecting data quality are immediately identified and corrective measures initiated. Upon completion of the audit, the Project QA Officer will prepare a written audit report, which summarizes the audit findings, identifies deficiencies, and recommends corrective actions. This report will be submitted to the Project Manager, who will be responsible for ensuring that corrective measures are implemented and documented (Section 3.1.2). The results of the audit process will be included in the QA reports to management, as described in Section 3.2.

3.1.1.2 Laboratory TSA

Laboratory TSAs may be conducted by AECOM as part of the analytical subcontractor monitoring program. The laboratory TSA will include a review of the following areas:

- QA organization and procedures;
- Personnel training and qualifications;

- Sample log-in procedures;
- Sample storage facilities;
- Analyst technique;
- Adherence to laboratory SOPs and project QAPP;
- Compliance with QA/QC objectives;
- Instrument calibration and maintenance;
- Data recording, reduction, review, and reporting; and,
- Cleanliness and housekeeping.

Preliminary results of the systems audit will be discussed with the Laboratory Manager, Laboratory Project Manager, and Laboratory QA Coordinator. A written report that summarizes audit findings and recommends corrective actions will be prepared and submitted to the Laboratory Manager for response, and to the Project Manager. The results of the audit, including resolution of any deficiencies, will be included in the QA reports to management, as described in Section 3.2.

3.1.1.3 Laboratory Deliverable Audits

All laboratory deliverables will be audited to verify that data packages contains all information required by the project and all information necessary to reproduce the reported results. EDDs will be audited to verify that they are compliant with data management specifications. Any deficiencies will be communicated to the laboratory and documented in the data validation reports.

3.1.1.4 Data Validations

Analytical data will be validated as described in Section 4.2. As part of the validation process, a review of each data validation checklist will be conducted by the QA Officer or designee. The review will verify that the data validation checklist was filled out accurately and completely, that all analytical data quality issues discussed, and the rationale for qualification of data documented

in the checklist. Any deficiencies noted by the QA Officer or designee will be discussed with the data validator prior to completion of the validation.

3.1.2 Response Actions

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out-of-limit QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective action proposed and implemented should be documented in the QA reports to management (Section 3.2). Corrective action should only be implemented after approval by the Project Manager, or his designee.

3.1.2.1 Field Corrective Action

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the QAPP, etc.), or when sampling procedures and/or field analytical procedures require modification, etc. due to unexpected conditions. The field team may identify the need for corrective action. The Field Manager will approve the corrective action and notify the Project Manager. The Project Manager, in consultation with the Project QA Officer, will approve the corrective measure. The Field Manager will ensure that the corrective measure is implemented by the field team.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The Project QA Officer or designee will identify deficiencies and recommend corrective action to the Project Manager. Implementation of corrective action will be performed by the Field Manager and field team. Corrective action will be documented in QA reports to the project management team (Section 3.2).

Corrective actions will be implemented and documented in the field record book. Documentation will include:

- A description of the circumstances that initiated the corrective action;

- The action taken in response;
- The final resolution; and,
- Any necessary approvals.

No staff member will initiate corrective action(s) without prior communication of findings through the proper channels.

3.1.2.2 Laboratory Corrective Action

Corrective action in the laboratory may occur prior to, during, and after initial analyses. A number of conditions such as broken sample containers, low/high pH readings, and potentially high concentration samples may be identified during sample log-in or analysis. Following consultation with laboratory analysts and supervisory personnel, it may be necessary for the Laboratory QA Coordinator to approve the implementation of corrective action. If the nonconformance causes project objectives not to be achieved, the Project Manager will be notified.

These corrective actions are performed prior to release of the data from the laboratory. The corrective action will be documented in both the laboratory's corrective action files, and in the narrative data report sent from the laboratory to the Project Manager. If the corrective action does not rectify the situation, the laboratory will contact the Project Manager, who will determine the action to be taken and inform the appropriate personnel.

3.1.2.3 Corrective Action During Data Validation and Data Assessment

The need for corrective action may be identified during either data validation or data assessment. Potential types of corrective action may include re-sampling by the field team or reinjection/reanalysis of samples by the laboratory. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected is necessary to meet the required QA objectives. If the data validator, data assessor, or QA Officer identifies a corrective action situation, the Project Manager will be responsible for informing the appropriate personnel.

3.2 REPORTS TO MANAGEMENT

QA reports will be submitted to the Project Manager to ensure any problems identified during the sampling and analysis programs are investigated and the proper corrective measures taken in response. If warranted, QA reports to internal corporate quality management teams will be submitted by the Project Manager in accordance with the Quality Management Plan (QMP). The QA reports will include:

- All results of field and laboratory audits;
- Problems noted during data validation and assessment; and,
- Significant QA/QC problems, recommended corrective actions, and the outcome of corrective actions.

QA reports will be prepared by the Project QA Officer and submitted on an as-needed basis.

4.0 DATA VALIDATION/DATA USABILITY

4.1 DATA REVIEW, VERIFICATION, AND VALIDATION

Data generated through field activities or through the analytical program will be verified and validated prior to reporting. No data will be disseminated by AECOM or its subcontractors until it has been subject to the procedures summarized below.

4.1.1 Field Data

Field data will be reviewed daily by the Field Manager to ensure records are complete, accurate, and legible and to verify sampling procedures are in accordance with the protocols specified in the FSAP and QAPP.

4.1.2 Internal Laboratory Review

Prior to the release of any data from the laboratory, the data will be reviewed and approved by laboratory personnel. The review will consist of a tiered approach including reviews by the person performing the work, by a qualified peer, and by supervisory and/or QA personnel.

4.1.3 Validation of Analytical Data

Laboratory data will be assessed for usability, completeness, and adherence to key QA/QC objectives for this project. One hundred percent (100%) of the analytical data will be validated using a procedure that is modeled after the USEPA Region IV and USEPA CLP guidance with changes and allowances made to conform to analytical methodology. At a minimum, the data will be reviewed for the following, as appropriate to the method:

- Technical holding times;
- Laboratory and equipment blank contamination;
- Surrogate spike recoveries;
- MS and MSD results;

- Laboratory duplicate results;
- LCS results;
- PCB confirmation sample results;
- Initial and continuing calibrations; and
- Instrument tuning, if GC/MS is used to confirm PCB sample results

Data validation protocols will be modeled after the EPA guidance developed for the analytical methods proposed for this project. These protocols identify the criteria to be used to accept, reject, or qualify data, and identify the data qualifiers applied. Equations used to evaluate the data quality are presented in Section 4.3.1.

4.2 VERIFICATION AND VALIDATION METHODS

4.2.1 Field Data Verification

Field records will be reviewed by the Field Manager to ensure that the following:

- Logbooks and standardized forms have been filled out completely and that the information recorded accurately reflects the activities that were performed;
- Records are legible and in accordance with good recordkeeping practices, i.e., entries are signed and dated, data are not obliterated, changes are initialed, dated, and explained; and,
- Sample collection, handling, preservation, and storage procedures were conducted in accordance with the protocols described in the FSAP and QAPP, and that any deviations were documented and approved by the appropriate personnel.

4.2.2 Laboratory Data Verification

Prior to being released as final, laboratory data will proceed through a tiered review process. Data verification starts with the analyst who performs a one hundred percent (100%) review of the data

to ensure the work was done correctly the first time. The data reduction and initial verification process must ensure:

- Sample preparation and analysis information is correct and complete;
- Analytical results are correct and complete;
- The appropriate SOPs have been followed and are identified in the project records;
- Proper documentation procedures have been followed; and,
- All non-conformances have been documented.

Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data will be performed by an experienced peer or supervisor. This check will be performed to ensure initial review has been completed correctly and thoroughly and will include a review of the following:

- Adherence to the requested analytical method SOP;
- Correct interpretation of chromatograms, mass spectra, etc.;
- Correctness of numerical input when computer programs are used (checked randomly);
- Correct identification and quantitation of constituents with appropriate qualifiers;
- Numerical correctness of calculations and formulas (checked randomly);
- Acceptability of QC data;
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.);
- Documentation of dilution factors, standard concentrations, etc.; and,
- Sample holding time assessment.

A third-level review will be performed by the Laboratory Project Manager or designee before the lab deliverable is submitted to AECOM (client). This review serves to verify the completeness of the laboratory deliverable and to ensure project requirements are met for the analyses performed. A narrative to accompany the final report will be prepared by the Laboratory Project Manager or designee.

4.2.3 Validation of Analytical Deliverables

Validation will be performed as described in Section 4.1.3 of this QAPP using a procedure modeled after the following U.S. EPA procedures and guidance:

- Region IV's Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services; and,
- Contract Laboratory Program, National Functional Guidelines for Organic Data Review.

Data validation protocols based on SW-846 analytical methodologies will be used in conjunction with the project-specific acceptance criteria defined in Section 1.6 of this QAPP to accept, reject, or qualify data.

Upon completion of the validation, a checklist will be prepared. This checklist will summarize the samples reviewed, elements reviewed, any non-conformances with the established criteria, and validation actions (including application of data qualifiers). Data qualifiers will be consistent with the EPA guidelines.

4.2.4 Verification during Data Management

All manually entered data (e.g., field data) will be proofed one hundred percent (100%) against the original. Electronic data will be checked one hundred percent (100%) after loading against laboratory data sheets for completeness and spot checked for accuracy.

4.3 RECONCILIATION WITH USER REQUIREMENTS

4.3.1 Comparison to Measurement Objectives

The field and laboratory data collected during this investigation will be used to achieve the objectives identified in Section 1.6 of this QAPP. Only data generated in association with QC results meeting the stated acceptance criteria (i.e., data determined to be valid) will be considered usable for decision making purposes.

4.3.1.1 Accuracy Assessment

One measure of accuracy will be percent recovery, which is calculated for MS, surrogates, and LCSs.

The formula for the matrix spike percent recovery calculation is:

$$\%\ \text{Recovery} = \frac{(Rs - Ru)}{S} \times 100$$

where: Rs – Result of the spiked sample analysis
Ru – Result of the unspiked sample analysis
S – Spike concentration

When determining the percent recovery for surrogate spikes or LCS, there is no "unspiked" sample analysis. Therefore, the calculation becomes:

$$\%\ \text{Recovery} = \frac{Rs}{S} \times 100$$

where: Rs – Result of the spiked sample or LCS analysis
S – Spike concentration

An additional measure of accuracy is blank contamination. The blanks associated with this project include laboratory method blanks and equipment blanks. The results of the laboratory and equipment blank analyses will be compared to the objectives stated Section 1.6.3 of the QAPP. Failure to meet these objectives may indicate a systematic laboratory or field problem that should

be investigated and resolved immediately. Associated data may be qualified and limitations placed on its use, depending on the magnitude of the problem.

4.3.1.2 Precision Assessment

The relative percent difference (RPD) between the MS and MSD, and field duplicate pair is calculated to determine if precision objectives (Section 1.6.3 of this QAPP) were met. Precision can be quantified by calculating the RPD of the results for a pair of duplicate samples according to the formula:

$$RPD = \left[\frac{|S_1 - S_2|}{\frac{(S_1 + S_2)}{2}} \right] x\ 100$$

where: S1 – original sample result
S2 – duplicate sample result

Failure to achieve precision objectives may result in the addition of qualifiers to the data (Section 4.2.3) and limitations placed upon its use.

4.3.1.3 Completeness Assessment

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and analysis. Valid results are all results not qualified with an "R" flag. Following completion of data validation, the percent completeness will be calculated by the following equation:

$$\%\,\text{Completeness} = \frac{\#\,\text{of Valid Results}}{\#\,\text{of Planned Results}} \times 100$$

Failure to meet the completeness objective will require an assessment to determine if the missing or invalid data are critical to achieving the project objectives. Corrective actions may include re-sampling or re-analysis, depending on the type of problem, logistical constraints, etc.

4.3.2 Comparison to Project Objectives

In addition to the assessments described in Section 4.3.1, the data obtained will be both qualitatively and quantitatively assessed on a project-wide, matrix-specific, and parameter specific basis. Factors to be considered in this assessment of field and laboratory data will include, but not necessarily be limited to, the following:

- Conformance to the field methodologies and SOPs proposed in the FSAP and QAPP;
- Conformance to the analytical methodologies provided in the QAPP;
- Adherence to proposed sampling strategy;
- Presence of elevated detection limits due to matrix interferences or contaminants present at high concentrations;
- Presence of analytes not expected to be present at the facility;
- Unusable data sets (qualified as "R") based on the data validation results;
- Data sets identified as usable for limited purposes (qualified as "J") based on the data validation results;
- Effect of qualifiers applied as a result of data validation on the ability to implement the project decision rules; and,
- Status of all issues requiring corrective action, as presented in the QA reports to management.

The effect of nonconformance (procedures or requirements) or noncompliant data on project objectives will be evaluated. Minor deviations from approved field and laboratory procedures and sampling approach will likely not affect the adequacy of the data as a whole in meeting the project objectives. Data that are estimated ("J" qualified) during the validation process will generally be considered usable, although any instances of extreme bias will be evaluated on a case-by-case basis to determine the limitations, if any, of the data usability. Missing or rejected data will be

reviewed to determine whether the data is critical to attaining the project objectives. The assessment will also entail the identification of any remaining data gaps and need to reevaluate project decision rules.

This assessment will be performed by the technical team, in conjunction with the Project QA Officer, and the results presented and discussed in detail in the final report.

5.0 REFERENCES

This QAPP was prepared using the following documents:

Consent Decree, October 2007; Docket No. 04-2017-3459; issued on October 23, 2017 by United Stated Environmental Protection Agency Region IV, Atlanta, Ga

United States Environmental Protection Agency, Region IV, Science and Ecosystem Support Division. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM),* November 2001.

United States Environmental Protection Agency, Quality Staff. *EPA Requirements for Quality Assurance Project Plans,* EPA QA/R-5. March 2001, reissued May 2006.

United States Environmental Protection Agency, Quality Staff. *Guidance for Quality Assurance Project Plans,* EPA QA/G-5. December 2002.

United States Environmental Protection Agency, Region 4, Science and Ecosystem Support Division. *Data Validation Standard Operating Procedures for Contract Laboratory Program Routine Analytical Services. February 2016.*

United States Environmental Protection Agency, *Contract Laboratory Program, National Functional Guidelines for Superfund Organic Methods Data Review*. June 2008

USEPA Region 4 SESD Field Branches Quality System and Technical Procedures, http://www.epa.gov/region4/sesd/fbqstp/

AECOM, November 2017; *Field Sampling and Analysis Plan for the Former Burlington Industries Cheraw Site, Cheraw, SC*; prepared by AECOM, 1360 Peachtree Street, Suite 500, Atlanta, GA 30309

FIGURES

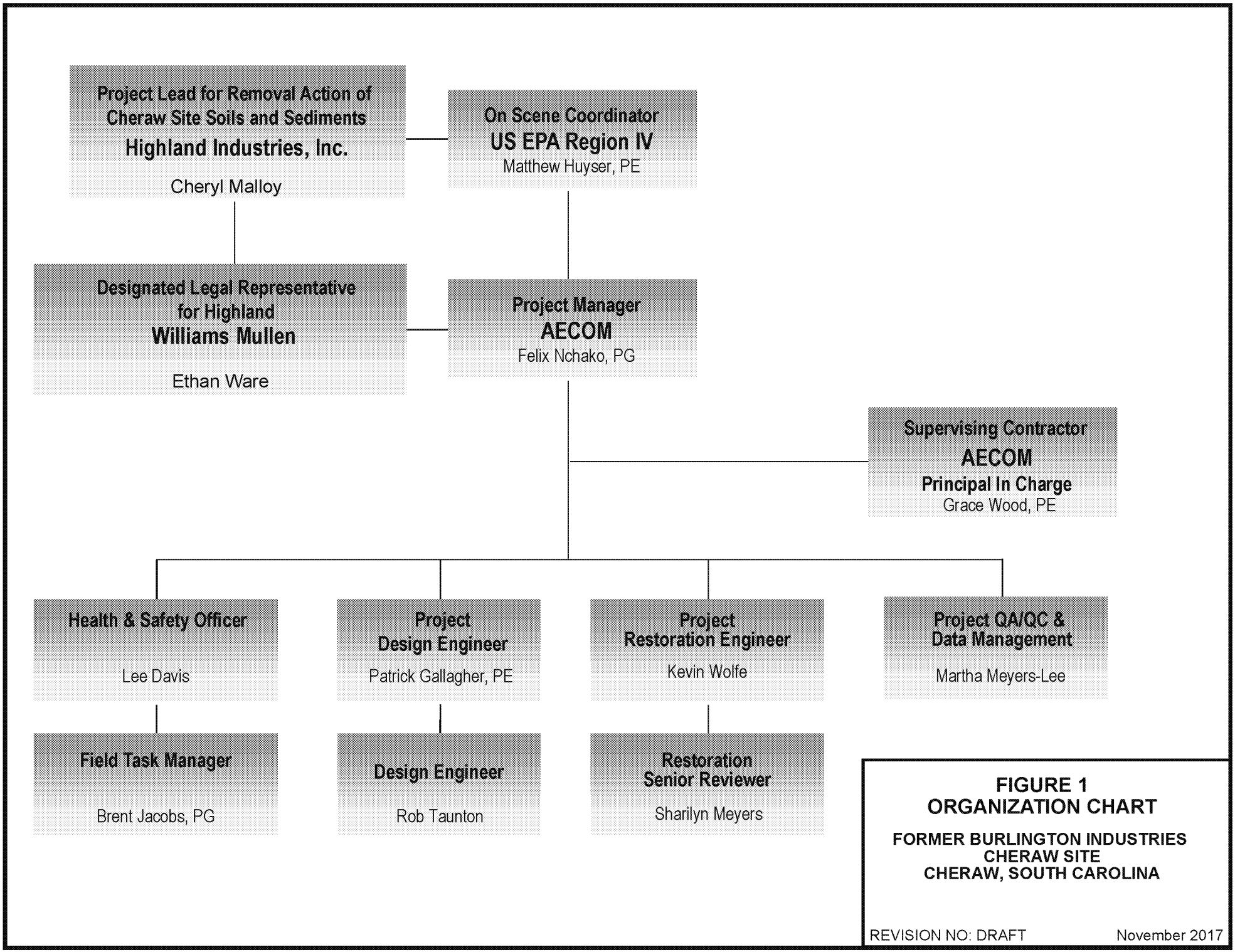

FIGURE 1
ORGANIZATION CHART

FORMER BURLINGTON INDUSTRIES
CHERAW SITE
CHERAW, SOUTH CAROLINA

REVISION NO: DRAFT November 2017

TABLES

Table 1

Analytical Laboratory DQOs for Precision and Accuracy for PCB Analyses

Parameter	Matrix	Compounds	Performance Standards[a] (mg/Kg)	Laboratory RL (mg/Kg)	Laboratory MDL[b] (mg/Kg)	Field Duplicate Precision[c] (% RPD)	Laboratory Precision[d, e] (% RPD)	Blanks	LCS/MSD[d] Accuracy (% R)	MS/MSD[d] Accuracy (% R)	Surrogate[d] Accuracy (% R)
PCB	Soil/ Sediment	Aroclor 1016	NA	0.0033	0.0011	≤50%RPD when sample concentrations >5x RL; absolute difference ≤2x RL when sample concentrations ≤5x RL	≤ 29	≤RL	70-130	50-150	NA
		Aroclor 1221	NA	0. 0033	0.0011				70-130	50-150	NA
		Aroclor 1232	NA	0. 0033	0.0011		≤ 30		70-130	50-150	NA
		Aroclor 1242	NA	0. 0033	0.0011				70-130	50-150	NA
		Aroclor 1248	NA	0. 0033	0.0011		≤ 30		70-130	50-150	NA
		Aroclor 1254	NA	0. 0033	0.0011				70-130	50-150	NA
		Aroclor 1260	NA	0. 0033	0.0011		≤ 30		70-130	50-150	NA
		Total PCB	1	0. 0033	0.0011				70-130	50-150	NA
							≤ 30				
		Surrogates:					≤ 30				
		DCB					≤ 33		NA	NA	32-139
		TMX					≤29		NA	NA	30-120
							NA				
							NA				

[a] Total PCB soil and sediment cleanup level goal is 1 mg/Kg for high occupancy areas and 25 mg/Kg for low occupancy areas
[b] Laboratory RLs and MDLs subject to change
[c] Provisions for wider acceptance limits near the PQL may be based on professional judgment during data review/validation.
[d] Limits are based on annual limits supplied by GEL Laboratories for soil/sediment samples. Actual limits will vary with the historical limits established by each individual laboratory.
[e] Lab duplicate or LCSD analyses to be conducted, if MS/MSD analyses unavailable.

%R Percent recovery
%RPD Percent relative percent difference
D Duplicate
DCB Decachlorobiphenyl
LCS Laboratory control sample
MS Matrix spike
NA Not Applicable.
PCB Polychlorinated biphenyls
RL Reporting limit
TMX Tetrachloro-m-xylene

Table 2

Sample Container, Preservation, Storage, and Holding Time Requirements

Matrix	Parameter[a]	Sample Container(s)	Recommended Sample Size	Preservative	Storage Conditions	Holding Time
Water	PCB (USEPA 8082A)	Amber bottle with Teflon-lined screw cap	2 L	None	Protect from light and Cool to ≤6°C	Extract within 1 year of collection and, analyze within 1 year following extraction[b]
Soil/ Sediment	PCB (USEPA 8082A)	Wide-mouth amber glass jar with Teflon-lined screw cap	250 mL (8 oz.)	None	Protect from light and Cool to ≤6°C	Extract within 1 year of collection and, analyze within 1 year following extraction[b]

[a] Analytical method is in parentheses.
[b] Based on Maximum Holding Time requirements cited in Table II of 40 CFR 136 for PCBs

°C Degrees Celsius
L Liter
mL Milliliter
oz Ounce
PCB Polychlorinated biphenyls
USEPA United States Environmental Protection Agency

Table 3

Analytical Methods

Analyte[a]	CAS #	Performance Standards[b] (mg/Kg)	Laboratory RL (mg/Kg)	Laboratory MDL[c] (mg/Kg)	DQO Level [d, e]
PCB (USEPA Method 8082A)					
Aroclor 1016	12674-11-2	NA	0.0033	0.0011	IV
Aroclor 1221	11104-28-2	NA	0.0033	0.0011	IV
Aroclor 1232	11141-16-5	NA	0.0033	0.0011	IV
Aroclor 1242	53469-21-9	NA	0.0033	0.0011	IV
Aroclor 1248	12672-29-6	NA	0.0033	0.0011	IV
Aroclor 1254	11097-69-1	NA	0.0033	0.0011	IV
Aroclor 1260	11096-82-5	NA	0.0033	0.0011	IV
Total PCB[f]	NA	1	0.0033	0.0011	IV

[a] Preparation and analytical methods are in parentheses after analyte. The methods used should be the most recent, USEPA-approved update of the above-mentioned methods

[b] Total PCB soil and sediment cleanup goal is 1 mg/Kg for high occupancy areas and 25 mg/Kg for low occupancy areas

[c] Laboratory RLs and MDLs subject to change

[d] DQOs (Data Quality Objectives) and QA/QC frequencies per Region 4 SESD Field Branches Quality System and Technical Procedures, which are available at http://www.epa.gov/region4/sesd/fbqstp/ . Level I = Field Screening; Level II = Field Analyses; Level III = Screening Data with Definitive Confirmation; Level IV = Definitive Data.

[e] PCB compound identification based on a single-column analysis must be confirmed on a second column or another qualitative technique. Primary and confirmation sample results are to be included in the laboratory report.

[f] Based on the sum of the seven Aroclor concentrations from the USEPA Method 8082A analysis

CAS Chemical Abstracts Service
DQO Data Quality Objectives
MDL Method detection limit
mg/Kg Milligrams per Kilograms
NA Not applicable
PCB Polychlorinated biphenyls
QA Quality Assurance
QC Quality Control
RL Reporting limit
SESD Science and Ecosystem Support Division
USEPA United States Environmental Protection Agency

Table 4

Field Instrument Calibration Procedures and Frequencies

Instrument/ Parameter	Frequency	Standards	Criteria	Corrective Action
pH	Prior to first sample measurement each day or if instrument has been off for > 4 hours.	Two buffers that bracket the expected range of readings.	Manufacturer's recommendations; or ± 0.1 pH unit depending on calibration method.	Recalibrate, if possible. Replace instrument.
	After every 15 samples or after the last use each day. Perform more often if necessary based on instrument response.	Check using a single buffer solution closest to the most recent readings.	± 0.1 pH unit of buffer.	Recalibrate, if possible. Replace instrument.
Specific Conductivity	Prior to first sample measurement each day or if instrument has been off for > 4 hours.	Two standards or as manufacturer recommends.	Manufacturer's recommendations; or ± 10% of true value depending on calibration method.	Recalibrate, if possible. Replace instrument.
	After every 15 samples or after the last use each day. Perform more often if necessary based on instrument response.	Check using a single standard solution closest to the most recent readings.	± 10% of true value.	Recalibrate, if possible. Replace instrument.
Turbidity	Prior to first sample measurement each day or if instrument has been off for > 4 hours.	Two standards or as manufacturer recommends.	Manufacturer's recommendations; or ± 10% of true value depending on calibration method.	Recalibrate, if possible. Replace instrument.
	After every 15 samples or after the last use each day. Perform more often if necessary based on instrument response.	Check using a single standard solution closest to the most recent readings.	± 10% of true value.	Recalibrate, if possible. Replace instrument.
PID/VOCs	Prior to first sample measurement each day or if instrument has been off for > 4 hours.	Isobutylene gas standard or as manufacturer recommends.	Manufacturer's recommendations; or ± 20% of true value depending on calibration gas.	Recalibrate, if possible. Replace instrument.
	After every 8-hour shift. Perform more often if necessary based on instrument response.	Check using a single standard solution closest to the most recent readings.	± 20% of true value.	Recalibrate, if possible. Replace instrument.

Notes:

Some instruments measure more than one parameter. In that case, the frequency and criteria apply to the parameter being measured instead of the instrument.

APPENDIXES

VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE

GEL LABORATORIES, LLC

QUALITY ASSURANCE PLAN

(GL-QS-B-001 REVISION 31)

PROPRIETARY INFORMATION

GEL

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SECTION 1
INTRODUCTION

Section 1 - Introduction

GEL Laboratories, LLC (GEL) is a privately owned environmental laboratory dedicated to providing personalized client services of the highest quality. Our mission is to be the "Analytical Firm of First Choice."

GEL was established as an analytical testing laboratory in 1981. Now a full service lab, our analytical divisions use state of the art equipment and methods to provide a comprehensive array of organic, inorganic, radiochemical, and bioassay analyses and related support services to meet the needs of our clients.

This Quality Assurance Plan provides an overview of our quality assurance program for analytical services. Outlined in this plan are the responsibilities, policies, and processes essential to maintaining client satisfaction and our high quality of performance. The Director of Quality Systems is responsible for revising, controlling, and distributing the QAP. It is updated/reviewed at least annually.

Everyone on our staff is expected to understand the policies, objectives, and procedures that are described in this plan and to fully appreciate our commitment to quality and their respective roles and responsibilities with regard to quality. We also expect any analytical subcontractors we employ to perform in accordance with the quality assurance requirements delineated in this plan. All GEL employees are required to participate in Annual Quality Systems training.

This Quality Assurance Plan (QAP) has been prepared according to the standards and requirements of the US Environmental Protection Agency (EPA), ANSI/ISO/IEC 17025-2005, and the National Environmental Laboratory Accreditation Conference (NELAC) Quality Systems Standards June 2003 effective July 2005, and the TNI (The NELAP Institute) Standards adopted in August, 2009.

1.1 Quality Policy

GEL's policy is "to provide high quality, personalized analytical services that enable our clients to meet their environmental needs cost effectively."

We define quality as "consistently meeting the needs and exceeding the expectations of our clients." As such, we consistently strive to:

- meet or exceed client and regulatory requirements
- be technically correct and accurate
- be defensible within contract specifications
- provide services in a cost-effective, timely and efficient manner

At GEL, quality is emphasized at every level—from the Chairman, CEO, Vice President, and COO to the newest of employees. Management's ongoing commitment to good professional practice and to the quality of our testing services to our customers is demonstrated by their dedication of personnel and resources to develop, implement, assess, and improve our technical and management operations.

The purpose of GEL's quality assurance program is to establish policies, procedures, and processes to meet or exceed the expectations of our clients. To achieve this, all personnel that support these services to our clients are introduced to the program and policies during their initial orientation, and annually thereafter during company-wide training sessions.

GEL's management is committed to compliance with and continual improvement of our quality assurance program. The program is designed to comply with the guidelines and specifications outlined in the following:

- NELAC 2003
- TNI 2009
- ASME/NQA-1
- ANSI/ISO/IEC 17025-2005
- QAPPs, U.S. EPA QA/R5
- Department of Energy Order 414.1B, 414.1C and 414.D
- Current U.S. EPA CLP statements of work for inorganic and organic analyses
- ANSI N42.23-1996 Measurement and Associated Instrument Quality Assurance for Radioassay Laboratories
- DOE STD 1112-98
- Performance Criteria for Radiobioassay- ANSI N13.30-1996.

- Energy Reorganization Act, 1974, Section 206, 10 CFR, Part 21
- MARLAP
- U.S. Department of Energy Quality Systems for Analytical Services Revisions 3.0 and 3.1
- U.S. Department of Defense Quality Systems Manual, Revision 4.2,5.0 and 5.1
- 10 CFR Part 21- Reporting of Defects and Noncompliance
- 10 CFR Part 50 Appendix B -Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
- 10 CFR Part 61- Licensing Requirements for Land Disposal of Radioactive Waste
- NRC REG Guide 4.8
- NRC REG Guide 4.15

1.2 Quality Goals

GEL's primary goals are to:

- Ensure that all measurement data generated are scientifically and legally defensible, of known and acceptable quality per the data quality objectives (DQOs), and thoroughly documented to provide sound support for environmental decisions.
- Ensure compliance with all contractual requirements, environmental standards, and regulations established by local, state and federal authorities.

Additional goals include:

- A comprehensive quality assurance program to ensure the timely and effective completion of each measurement effort.
- A commitment to excellence and improvement at all levels of the organization.
- Early detection of deficiencies that might adversely affect data quality.
- Adequate document control.
- Effective quality assurance objectives for measurement systems and for quality data in terms of accuracy, precision, completeness, and comparability through the use of proven methods.
- The establishment of procedures that demonstrate that the analytical systems are in a state of statistical control.
- The implementation of corrective actions and improvements to ensure the integrity of data.
- Reduction of data entry errors through comprehensive automated data handling procedures.
- The development and implementation of good laboratory and standard operating procedures (SOPs).
- Ability to customize quality assurance procedures to meet a client's specific requirements for data quality.
- Good control of instruments, services, and chemical procurement.
- A continuously capable laboratory information management system (AlphaLIMS).
- Validated and documented computer hardware and software.
- All employees who have access to the AlphaLIMS system are required to participate in computer security awareness training annually.

1.3 Key Quality Elements

A sound quality assurance program is essential to our ability to provide data and services that consistently meet our high standards of integrity. The key features of our program are:

- An independent quality assurance (QA) validation and Quality Systems Department.
- A formal quality policy and QAP.
- Management review.
- Stated data quality objectives.
- A comprehensive employee training program.
- Ethics policy and education program.
- Internal audits and self-evaluations.
- A closed-loop corrective action program.
- State-of-the-art facilities and instruments.
- Adherence to standard operating procedures.
- EPA/NIST traceable reference materials.
- Electronically based document control.
- Chain of custody and electronic sample tracking.

- Inter-laboratory comparison programs.
- Formal laboratory accreditations.
- The evaluation of subcontractor laboratories.
- Statistical controls for analytical precision and accuracy.
- Replicate, method blank, matrix spike, tracer yield, internal standards, and surrogate measurements.
- The preventive maintenance of instrumentation and equipment.
- Independently prepared blind standard reference materials.
- Multi-level review processes.
- Focus on client satisfaction.
- Electronic tracking of client commitments, nonconformances and corrective actions.
- Trend analysis of nonconforming items.

1.4 Management Reviews

The effectiveness of the Quality System is reviewed at least annually by Senior Management. These reviews address issues that impact quality, and the results of the reviews are used to develop and implement improvements to the system. Records of the review meetings are maintained as quality documents.

1.5 Disposition of Client Records

In the event that the laboratory should change ownership, the responsibility for the maintenance and disposition of client records shall transfer to the new owners. In the unlikely event that the laboratory ceases to conduct business, clients shall be notified and asked to provide instructions as to how their records should be returned or disposed. If a client does not provide instructions, those records will be maintained and disposed in a manner consistent with regulations and good laboratory practices for quality records.

1.6 Supporting Documents

Our laboratory operations and the quality of our analytical data comply with the specifications described in the documents listed in Appendix A.

1.7 Definitions

Applicable definitions are listed in Appendix B.

SECTION 2
ORGANIZATION, MANAGEMENT, AND PERSONNEL

Section 2 - Organization, Management, and Personnel

The chart found in Appendix C depicts our corporate organization, chain of command and flow of responsibility. The illustration in this appendix is designed to ensure the overall quality and cost efficiency of our company's analytical products and services.

Our structure is based on customer-focused divisions that follow a project from the point of initial contact to the final invoicing of work. These divisions include expertise in project management, sample receipt and custody, sample preparation and analysis, data review, and data packaging. An independent Quality Systems Management Department monitors the adherence of these divisions to the Quality Assurance Program.

The general responsibilities associated with the following position levels are discussed in this section:

- Chairman
- Chief Executive Officer (CEO) and President
- Vice President
- Chief Operating Officer (COO)
- Quality Systems Director
- Laboratory Directors
- Project Managers
- Group Leaders
- Laboratory and Technical Staff
- Information Systems Manager
- Environmental Manager
- Radiation Safety Officer
- Director of Human Resources

An overview of GEL's employee training protocol is also provided at Section 2.12.

2.1 Chairman, CEO/President, Chief Financial Officer and Chief Operating Officer

Operational responsibility rests with GEL's three owners, and COO. Kathleen H. Stelling, James M. Stelling, and Joseph M. Hodgson are GEL's owners and serve respectively as Chairman, CEO/President, and Vice President. Carey J. Bocklet occupies the position of COO. As the highest level executives, their philosophical approach to quality, technology and customer service keeps GEL unique.

The Stellings, Mr. Hodgson and Ms. Bocklet comprise our Executive Committee. They are also part of a Leadership Team that works to create a workplace environment that attracts and retains highly qualified professionals.

As Chairman, Ms. Stelling oversees the Executive Committee and leads management in implementing total quality initiatives that ensure quality services that meet stringent criteria of excellence. She has responsibility for public relations efforts and community affairs. Ms. Stelling holds a Bachelor of Arts in Education from the University of South Carolina.

As CEO and President, Mr. Stelling has overall operational responsibility for GEL. He operates the laboratory according to corporate policies and applicable licenses and regulations.

Mr. Stelling also has primary responsibility for the development and administration of our analytical testing and environmental consulting services. He holds a Bachelor of Science in Commerce from the University of Virginia.Mr. Joseph M. Hodgson is GEL's Vice President. He is responsible for Strategic Planning, Marketing and Business Development. Mr. Hodgson holds a Bachelor of Science in Business and a minor in Spanish from Wake Forest University.

The Chief Operating Officer is Carey J. Bocklet. Ms. Bocklet is responsible for the daily operations of the laboratories and client services. Ms. Bocklet holds a Bachelor of Science in Chemical Engineering, and a Master of Science in Business Administration, both from Clemson University.

Together, the Chairman, CEO/President, Vice President, and COO form GEL's Executive Committee. Their responsibilities include the following:

- Ensuring that the individuals who staff our technical and quality positions have the necessary education, training, and experience to competently perform their jobs.
- Ensuring that all staff members receive ancillary training, as needed, to enhance performance in assigned positions.
- Budgeting, staffing, managing, and equipping the laboratory to meet current and future analytical program requirements.
- Overseeing the implementation and overall effectiveness of our Quality Assurance Plan, health and safety initiatives, and environmental programs.
- Managing production and cost control activities.
- Ensuring development of capabilities in response to new or revised regulations, instrumentation and procedures, and quality assurance initiatives.

2.2 Technical Laboratory Co-Directors

To enhance our responsiveness to clients through dedicated expertise and teamwork, our laboratory is divided into two major divisions, Chemistry and Radiochemistry, each with its own Technical Laboratory Director.

The Technical Directors report to the Executive Committee and are ultimately responsible for the technical content and quality of work performed within each division. They are also responsible for strategic planning, profitability and growth, personnel management and business development. Other responsibilities include:

- Monitoring and meeting profitability and growth objectives of the division.
- Establishing and implementing short and long range objectives and policies that support GEL's goals.
- Defining the minimum level of qualification, experience, and skills necessary for positions in their divisions.
- Establishing and implementing policies and procedures that support our quality standards.
- Ensuring that technical laboratory staff demonstrates initial and continuing proficiency in the activities for which they are responsible.
- Documenting all analytical and operational activities of the laboratory.
- Supervising all personnel employed in the division.
- Ensuring that all sample acceptance criteria are verified and that samples are logged into the sample tracking system, properly labeled, and stored.
- Documenting the quality of all data reported by the division.
- Developing internal mechanisms and measurements to improve efficiency.
- Overseeing activities designed to ensure compliance with laboratory health and safety requirements.
- Allocating the resources necessary to support an effective and ongoing quality assurance program.
- Representing the company to the public and to clients.
- Ensuring the appropriate delegation of authorities during periods of absence.
- Ensuring compliance to the ISO 17025:2005 Standard.

Due to high volume and variety of analytical tests performed in the Chemistry Laboratory, the Technical Director for the Chemistry Laboratory has the daily assistance of a Production Manager and Group Leaders.

2.3 Quality Systems Director

Our Quality Systems Director (QSD) reports directly to the CEO. The QSD manages the design, implementation and maintenance of our quality systems in a timely, accurate, and consistent manner.

In addition to having responsibility for the initiation and recommendation of corrective and preventive actions, the QSD is responsible for:

- Establishing, documenting, and maintaining comprehensive and effective quality systems.

- Developing and evaluating quality assurance policies and procedures pertinent to our laboratory functions, and communicating these with the division directors and managers.
- Ensuring that the operations of the lab are in conformance with the Quality Assurance Plan and meet the quality requirements specific to each analytical method.
- Ensuring that laboratory activities are in compliance with local, state, and federal environmental laws and regulations.
- Reviewing project-specific quality assurance plans.
- Ensuring that quality control limits are established and followed for critical points in all measurement processes.
- Initiating internal performance evaluation studies using commercially purchased certified, high-purity standard reference materials.
- Performing independent quality reviews of randomly selected data reports.
- Conducting periodic audits to ensure method compliance.
- Conducting or arranging periodic technical system evaluations of facilities, instruments and operations.
- Overseeing and monitoring the progress of nonconformance's and corrective actions.
- Communicating system deficiencies, recommending corrective action to improve the system, and defining the validity of data generated during out of control situations.
- Preparing and updating quality assurance documents and reports to management.
- Coordinating inter-laboratory reviews and comparison studies.
- Overseeing Stop Work Orders in out-of-control situations.
- Administering accreditation and licensing.
- Administering our document control system.
- Providing guidance and training to laboratory staff as requested.
- Evaluating subcontractors and vendors that provide analytical and calibration services.
- Designating quality systems authorities in times of absence to one or more appropriately knowledgeable individuals.
- Overseeing notification if required for compliance with Energy Reorganization Act, 1974, 10 CFR, Part 21, should data recall be necessary.

2.4 Quality Systems Review

The effectiveness of the Quality System is reviewed on a regular basis during meetings of the Leadership Team, which may be as often as weekly, but not less than quarterly. These meetings address issues that impact quality, and the subsequent discussions are used to design and implement improvements to the system. At least annually, a management assessment of GEL's Quality System is conducted and reported. The QSD maintains records of these assessments.

2.5 Manager of Client and Support Services

Project Managers (PMs) serve as primary liaisons to our clients. PMs, under the guidance of the Manager of Client and Support Services, manage the company's interaction with clients. They are the client's first point of contact and have responsibility for client satisfaction and for communicating project specifications and changes to the appropriate laboratory areas.

Additional responsibilities include:

- Retaining clients and soliciting new work.
- Managing multiple sample delivery orders and preparing quotes.
- Working with clients to define analytical methodologies, quality assurance requirements, reports, deliverables, and pricing.
- Overseeing sample management and informing laboratory staff of the anticipated arrival of samples for analysis.
- Conducting a review of client documents (i.e. quotes, invoices, routine and specialized reports).
- Working with the accounting team on invoicing and collection issues.

- Working with the Laboratory Directors, Production Manager, and Group Leaders to project workloads and determine schedules.

2.6 Production Manager and Group Leaders

Group Leaders are a critical link between project management, lab personnel, and support staff. They report to the Technical Directors and have the following responsibilities:

- Planning and coordinating the operations of their groups to meet client expectations.
- Scheduling sample preparation and analyses according to holding times, quality criteria, and client due dates.
- Ensuring a multi-level review of 100% of data generated by their groups.
- Coordinating nonconformances and corrective actions in conjunction with the Quality Systems Management team.
- Serving as technical resources to their groups, including data review.
- Managing special projects, reviewing new work proposals, and overseeing the successful implementation of new methods.
- Monitoring and controlling expenses incurred within their groups such as overtime and consumables.
- Providing performance and career development feedback to their group members.

2.7 Laboratory and Technical Staff - General Requirements

At GEL, every effort is made to ensure that the laboratory is sufficiently staffed with personnel who have the training, education, and skills to perform their assigned jobs competently.

Depending upon the specific position, laboratory personnel are responsible for:

- Complying with quality assurance and quality control requirements that pertain to their group and/or technical function.
- Demonstrating a specific knowledge of their particular function and a general knowledge of laboratory operations.
- Understanding analytical test methods and standard operating procedures that are applicable to their job function.
- Documenting their activities and sample interactions in accordance with analytical methods and standard operating procedures.
- Implementing the quality assurance program as it pertains to their respective job functions.
- Identifying potential sources of error and reporting any observed substandard conditions or practices.
- Identifying and correcting any problems affecting the quality of analytical data.
- Identifying and performing all client specific requirements outlined in the special requirements on the pull sheet of every batch.

2.8 Information Systems Manager

The Information Systems Manager reports directly to the COO. The responsibilities of this position include management of the Computer Services Team and AlphaLIMS, our laboratory information management system.

The combined responsibilities of the Information Systems Team, performing under the leadership of the Information Systems Manager, include the:

- Development and maintenance of all software and hardware.
- Translation and interpretation of routines for special projects.
- Interpretation of general data and quality control routines.
- Optimization of processes through better software and hardware utilization.
- Customization, testing and modification of data base applications.
- Maintenance and modification of our computer modeling, bar coding, CAD, statistical process control, project management, and data packaging systems.
- Development and maintenance of client and internal electronic data deliverables.

- Validation and documentation of software used in processing analytical data.

2.9 Environmental Manager

The Environmental Manager oversees our physical facility, laboratory and radiation safety programs, and instrumentation. This position reports to the COO, and manages and supervises the functions and staff assigned to these areas.

Responsibilities of the Environmental Manager include:

- Planning, evaluating, and making recommendations for facility maintenance, additions and renovations.
- Overseeing building renovations and new construction activities.
- Implementation of the Chemical Hygiene and Radiation Safety programs.
- Installing, maintaining, repairing, and modifying analytical instrumentation.
- Providing technical expertise and training in instrumentation operation, calibration, and maintenance.
- Monitoring and ensuring regulatory compliance for waste management operations and off-site disposal.

2.10 Radiation Safety Officer

The Radiation Safety Officer (RSO) reports to the COO. The RSO is responsible for the administration and execution of GEL's Radiation Protection Program. This person provides technical guidance and leadership for all issues concerning radiation health and safety as well as direct operations to ensure compliance with South Carolina Department of Health and Environmental Control (SCDHEC) regulations for radioactive materials.

Responsibilities of the RSO include:

- Establishing and enforcing policies consistent with the principles and practices designated to maintain all exposure to ionizing radiation "As Low As Reasonably Achievable" (ALARA).
- Supervising Radiation Protection Specialists in the execution of radiological surveys and maintenance of the Radioactive Material License inventory.
- Executing the Personal Dosimetry, Air Effluent Monitoring, and Sealed Radioactive Source Leak Test Programs.
- Developing procedures and protocols to establish and maintain compliance.
- Providing training for staff in proper radiation protection practices.

2.11 Director of Human Resources

The Director of Human Resources reports directly to the CEO. The DHR manages the design, implementation, and ongoing development of our Human Resources. Responsibilities of the DHR include:

- Administration, orientation, and indoctrination of all new employees.
- Administration and compliance with Federal, State, and Local employment regulations.
- Sourcing candidates for all functional positions to maintain and strengthen the technical services provided by GEL.
- Management of occupational health and safety as it relates to Federal, State, and OSHA regulations.

2.12 Employee Training

To ensure that our clients receive the highest quality services possible, we train our employees in the general policies and practices of the company, as well as the specific operating procedures relative to their positions. We conduct and document this training according to GL-HR-E-002 for Employee Training and GL-QS-E-017 for Maintaining Technical Training Records.

New employees participate in a company orientation shortly after they are hired. During orientation they receive information on quality systems, ethics/data integrity, laboratory safety, and employment practices. Each new employee is also provided a

manual that reiterates our policies on equal opportunity, benefits, leave, conflicts of interest, employee performance, and disciplinary action. Employees can access standard operating procedures, the Quality Assurance Plan, Safety, Health, and Chemical Hygiene Plan, and the Laboratory Waste Management Plan on GEL's Intranet.

Other training provided on an ongoing basis may include:

- Demonstration of initial proficiency in analytical methods and training to SOPs conducted by a trainer who has been documented as qualified and proficient in the process for which training is being provided.
- Demonstration of continued analyst proficiency is updated continuously, using the most recent data available in AlphaLIMS. Proficiency is demonstrated using the same processes as those used for initial Demonstration of Capability. (Refer to Section 8.3.1.)
- Company-wide, onsite training.
- Courses or workshops on specific equipment and analytical techniques.
- University courses.
- Professional and trade association conferences, seminars, and courses.

Documentation of employee training is the joint responsibility of the employee and the applicable Group Leader. If an SOP is revised during the course of the year, training to the revised SOP must be documented.

2.13 Ethics and Data Integrity

As our corporate vision statement explains, "We are a company that values: Excellence as a way of life, Quality Service, a Can-Do attitude, and a fundamental commitment to Ethical Standards." Employees attend ethics education programs that focus on the high standards of data integrity and ethical behavior mandated by our company and expected by our clients.

The annual ethics training includes:

- Specific examples of unethical behaviors for the industry and for the laboratory.
- Explanation of Internal Auditing for unethical behaviors and practices.
- GEL use of electronic audit functions using instrument and AlphaLIMS software.
- Explanation of GEL's Ombudsman policy for reporting inappropriate activities.
- Examples of consequences of inappropriate or unethical behaviors/practices.

All employees sign an Ethics and Data Integrity Agreement that reflects their commitment to always perform their duties with these high standards. (Refer to Appendix F.) During the initial and continuing Ethics and Data Integrity training, GEL's policy on confidential reporting of potential integrity issues is thoroughly discussed. Potential business or data integrity issues are handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. All investigations are confidentially processed by GEL's QSD, or other members of GEL's Laboratory Management staff under the direction of the QSD. All investigations that result in finding of inappropriate activity are properly documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. The QSD is responsible for updating GEL's Executive Committee on the progress of integrity investigations during regularly scheduled meetings.

2.14 Confidentiality

The laboratory maintains the confidentiality and proprietary rights of information including the type of work performed and results of analysis. Laboratory personnel and staff are informed of this policy and sign a confidentiality agreement.

A confidentiality statement accompanies the electronic transfer of data from GEL via telefacsimile (fax) or electronic mail systems (email). Government affiliated auditing agencies have access to pertinent laboratory records. However, contract, third party, and client auditors have access only to those records that may be applicable to their inspection and shall not be granted access to client records that may be considered in conflict with their interests, unless prior authorization has been given by the submitting client. Confidential information may be purged of references to client identity, project and/or sample identity by the laboratory

so that records may be provided to other entities (e.g. auditors) for review.

SECTION 3
QUALITY SYSTEMS

Section 3 - Quality Systems

Our Quality Systems include all quality assurance (QA) policies and quality control (QC) procedures necessary to plan, implement, and assess the work we perform. GEL's QA Program establishes a quality management system (QMS) that governs all of the activities of our organization.

GEL's quality management system is designed to conform to the requirements specified in the standards referenced in Appendix A. Essential elements of our quality management system are described in this section and Appendix E.

3.1 Quality Systems Team

The quality systems team is responsible for managing GEL's QA Program. This team functions independently of the systems it monitors and is comprised of the Quality Systems Director, Lead Auditor, QA Officers,Specialists, and Document Control Officer.

Following is a summary of the responsibilities of each position.

3.1.1 Quality Systems Director

- Reports to the CEO
- Demonstrates strict adherence to and support of the company ethics policy
- Serves as management's representative for quality
- Responsible for the implementation and maintenance of the QMS
- Supervises the Quality Systems Team and their functions
- Initiates and recommends preventive action and solutions to quality problems
- Implements appropriate action to control quality problems until solutions are implemented and verified to be effective
- Verifies that effective solutions are implemented
- Demonstrates knowledge of the Quality System as defined by NELAC, TNI, NUPIC, ANSI/ISO/IEC 17025, DOECAP, and DOELAP.

3.1.2 Quality Systems Lead Auditor

- Reports to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Demonstrates knowledge of the Quality Systemdefined under NELAC, TNI, DOECAP,DOELAP, NUPIC and other quality standards such as ANSI/ISO/IEC 17025-2005.
- Plans, schedules and participates in GEL's client audits, internal audits, and subcontractor audits
- Conducts conformance audits as necessary to verify implementation and closure of audit action items
- Serves as liaison to client and third party auditors
- Coordinates laboratory responses to audit reports and prepares final response
- Monitors progress of corrective actions
- Prepares and monitors progress of internal and subcontractor audit reports

3.1.3 Quality Assurance Officers

- Report to the Quality Systems Director
- Demonstrate strict adherence to and support of the company ethics policy.
- Demonstrate the ability to evaluate data objectively without outside influence
- Have documented training and/or experience in QA/QC procedures and knowledge of the Quality system as defined under NELAC, TNI and ISO 17025
- Have knowledge of analytical methods
- Assist in the conduct of internal and supplier audits and requests for pricing reviews
- Administer corrective actions and nonconformances

- Monitor and respond to client -identified nonconformances and technical inquiries
- Implement and maintain statistical process control (SPC) system
- Ensure the monitoring of balances and weights, and temperature regulation of ovens, water baths, and refrigerators
- Coordinate the monitoring of DI water system and volatile organics storage coolers
- Maintain Method Detection Limit studies
- Write or review quality documents and standard operating procedures under the direction of the QS Director
- Provide training in quality systems and good laboratory practices.
- Manage laboratory certification processes
- Coordinate the receipt and disposition of external and internal performance evaluation samples.

NOTE: Once PE samples have been prepared in accordance with the instructions provided by the PE vendor, they are managed and analyzed in the same manner as environmental samples from clients. The analytical and reporting processes for PE samples are not specially handled.

3.1.4 Quality Systems Specialists/Document Control Officer

- Reports to the Quality Systems Director
- Demonstrates strict adherence to and support of the company ethics policy.
- Assist the team as directed with respect to Records Management, Document Control, Laboratory Certification, temperature and weight calibrations, logbook review, training documentation, and nonconformances, etc.

3.2 Quality Documents

Our Quality Systems policies and procedures are documented in this and other supporting documents. GEL's management approves all company quality documents. Pre-approval is secured for any departures from such documents that may affect quality.

In addition, to the QA Plan, Quality Systems allows for QA Project Plans (QAPjP) and includes standard operating procedures and any other quality assurance program requirements defined by individual contracts. The QA Plan describes the quality standards that we apply to our laboratory operations. We use Quality Assurance Project Plans to specify individual project requirements. The QA Plan and supporting documents are verified to be understood and are implemented throughout the laboratory fractions to which they apply.

Finally, our Standard Operating Procedures (SOPs) are used to describe in detail those activities that affect quality. SOPs are prepared, authorized, changed, revised released, and retired in accordance with GL-ADM-E-001. SOPs are accessible electronically via GEL's Intranet.

3.3 Document Control

The control of quality documents is critical to the effective implementation of our Quality Program. We define and control this process in accordance with GL-DC-E-001 for Document Control. Responsibilities for document control are divided between the Group Leaders and the Document Control Officer (DCO).

Group Leaders are responsible for:

- Supporting the development and maintenance of controlled documents that apply to their respective departments.
- Reviewing all quality documents annually for continued validity.
- Ensuring documentation that the affected employees are aware of revisions to documents or manuals.

The Computer Services Team is responsible for:

- Electronic maintenance of all records required for control, re-creation, and maintenance of analytical documentation.
- Maintenance of electronic copies of archived data and the electronic log of how they were determined.

The DCO is responsible for:

- Demonstrating strict adherence to and support of the company ethics policy.
- Managing the system for the preparation, authorization, change, revision, release, and retirement of the Quality Manual, QAP, project plans, and standard operating procedures.
- Ensuring that current controlled documents are accessible via GEL's Intranet.

- Managing a system to document current revision numbers and revision dates for all distributed documents and manuals.
- Managing a system to identify the nature of document revisions.
- Maintaining hard or electronic copies of obsolete documents.
- Maintaining electronic or hard copy originals of all controlled documents.

Revisions to controlled quality documents are made by replacing individual sections or the entire document, as determined by the DCO.

3.4 Controlled Document Review

Internally generated controlled documents undergo a multi-level review and approval process before they are issued. These levels include a procedural review, technical and/or quality review and the final authorization of the appropriate manager or director. To ensure that new or revised standard operating procedures are not implemented prematurely, SOPs are effective upon the date of the final approval signature.

3.5 Quality Records

Quality records provide evidence that specified quality requirements have been met and documented. We generate them in accordance with applicable procedures, programs, and contracts. Quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- Audit records
- Run logs, instrument data, and analytical logbooks
- Instrument, equipment, and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports and corrective actions
- Method development and start-up procedures including method detection limit studies
- Technical training records
- Waste management records
- Standard logs
- Software validation documentation
- Standard Operating Procedures (SOPs)
- Sample collection and field data

Our quality records are:

- Documented in a legible manner.
- Indexed and filed in a manner conducive to ready retrieval.
- Stored in a manner that protects them from loss, damage, and unauthorized alterations.
- Accessible to the client for whom the record was generated.
- Retained and disposed in the identified time period.

The generation, validation, indexing, storage, retrieval, and disposition of our quality records are detailed in GL-QS-E-008 for Quality Records Management and Disposition. The quality records of subcontracted services are also required to meet the conditions established in this SOP.

3.6 Internal and Supplier Quality Audits

We conduct internal audits annually to verify that our operations comply with the requirements of our QA program and those of our clients. We perform supplier audits as necessary to ensure that they too meet the requirements of these programs. Both internal and supplier audits are conducted in accordance with GL-QS-E-001 for the Conduct of Quality Audits.

3.6.1 Audit Frequency

Internal audits are conducted at least annually in accordance with a schedule approved by the Quality Systems Director. Supplier audits are contingent upon the categorization of the supplier, and may or may not be conducted prior to the use of a supplier or subcontractor (Refer to GL-QS-E-001.) Type I suppliers and subcontractors, regardless of how they were initially qualified, are re-evaluated at least once every three years.

Additional internal and supplier audits may be scheduled if deemed necessary.

3.6.2 Audit Team Responsibilities

Internal and supplier audits are conducted by qualified staff under the direction of the Lead Auditor or

Quality Systems Director. A qualified audit team member shall have the technical expertise to examine the assigned activities.

We do not allow staff to audit activities for which they are responsible or in which they are directly involved. It is the responsibility of the Lead Auditor to ensure that such conflicts of interest are avoided when the audit team is assembled.

The Leadership Team has a significant role in the internal audit process, including:

- Provision of audit personnel
- Empowerment of the audit team with authority to make the audit effective
- Development and implementation of timely corrective action plans

3.6.3 Identification and verification of OFIs

Opportunities for Improvement are identified conditions that have potential to improvethe quality of products or services. Several examples of objective evidence are used to support an OFI, which might be classified as an , observation, and/or recommendation.

The Lead Auditor may initiate an OFI and may reference a Nonconformance Report (NCR) or Corrective Action Request and Report (CARR) The OFI, is then entered into the NCR system per GL-QS-E-012 for NCR Database Operation.

Implementation of any changes or action is verified as effective prior to implementation. The OFI may be verified for continued effective implementation during the next scheduled audit.

3.7 Managerial and Audit Review

Our Leadership Team reviews the audit process at least annually. This ensures the effectiveness of the corrective action plan and provides the opportunity to introduce changes and improvements.

We document all review findings and corrective actions. Implementation plans and schedules are monitored by the Quality Systems Team.

3.8 Nonconformances

Processes, materials, and services that do not meet specifications or requirements are defined as nonconforming. Such nonconformances can include items developed in-house or purchased from vendors, samples received from clients, work in progress, and client reports.

At GEL, we have a nonconformance reporting system (NCR) that helps us prevent the entry of defective goods and services into our processes and the release of nonconforming goods and services to our clients. Our NCR system provides a means for documenting the disposition of nonconforming items and for communicating these to the persons involved in the process affected by the adverse condition(s).

Nonconformances are documented according to GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. We regularly review SOPs, client complaints, and quality records, including completed NCRs, to promptly identify conditions that might result in situations or services that do not conform to specified quality requirements.

Our Quality Group processes, categorizes and trends nonconformances. Trending information may be provided to the Leadership Team and Group Leaders of the affected areas.

3.9 Corrective Action

There are two categories of corrective action at GEL. One is corrective action implemented at the analytical and data review level in accordance with the analytical SOP. The other is formal corrective action documented by the Quality Systems Team in accordance with GL-QS-E-002. Formal corrective action is initiated when a nonconformance reoccurs or is so significant that permanent elimination or prevention of the problem is required.

We include quality requirements in most analytical SOPs to ensure that data are reported only if the quality control criteria are met or the quality control measures that did not meet the acceptance criteria are documented.

Formal corrective action is implemented according to GL-QS-E-002 for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement and documented according to GL-QS-E-012 for NCR Database Operation.

Any employee at GEL can identify and report a nonconformance and request that corrective action be taken. Any GEL employee can participate on a corrective action team as requested by the QS team or Group

Leaders. The steps for conducting corrective action are detailed in GL-QS-E-002.

In the event that correctness or validity of the laboratory's test results is doubted, the laboratory will take corrective action. If investigations show that the results have been impacted, affected clients will be informed of the issue in writing within 5 calendar days of the discovery.

3.10 Performance Audits

In addition to internal and client audits, our laboratory participates in annual performance evaluation studies conducted by independent providers. We routinely participate in the following types of performance audits:

- Proficiency testing and other inter-laboratory comparisons.
- Performance requirements necessary to retain certification (Appendix D).
- Evaluation of recoveries of certified reference and in-house secondary reference materials using statistical process control data.
- Evaluation of relative percent difference between measurements through SPC data.

We also participate in a number of proficiency testing programs for federal and state agencies and as required by contracts. It is our policy that no proficiency evaluation samples be analyzed in any special manner.

Our annual performance evaluation participation generally includes a combination of studies that support the following:

- US Environmental Protection Agency Discharge Monitoring Report, Quality Assurance Program (DMR-QA). Annual national program sponsored by EPA for laboratories engaged in the analysis of samples associated with the NPDES monitoring program. Participation is mandatory for all holders of NPDES permits. The permit holder must analyze for all of the parameters listed on the discharge permit. Parameters include general chemistry, metals, BOD/COD, oil and grease, ammonia, nitrates, etc.
- Department of Energy Mixed Analyte Performance Evaluation Program (MAPEP). A semiannual program developed by DOE in support of DOE contractors performing waste analyses. Participation is required for all laboratories that perform environmental analytical measurements in support of environmental management activities.
- ERA's MRAD-Multimedia Radiochemistry Proficiency test program. This program is for labs seeking certification for radionuclides in wastewater and solid waste. The program is conducted in strict compliance with USEPA National Standards for Water Proficiency study.
- ERA's InterLaB RadCheM Proficiency Testing Program for radiological analyses. This program completes the process of replacing the USEPA EMSL-LV Nuclear Radiation Assessment Division program discontinued in 1998. Laboratories seeking certification for radionuclide analysis in drinking water also use the study. This program is conducted in strict compliance with the USEPA National Standards for Water Proficiency Testing Studies.
- Water Pollution (WP). Biannual program for waste methodologies. Parameters include both organic and inorganic analytes.
- Water Supply (WS): Biannual program for drinking water methodologies. Both organic and inorganic parameters are included.

At GEL, we also evaluate our analytical performance on a regular basis through statistical process control acceptance criteria. Where feasible, this criterion is applied to both measures of precision and accuracy and is specific to sample matrix.

We establish environmental process control limits at least annually. In Radiochemistry, quality control evaluation is based on static limits rather than those that are statistically derived, unless specified by regulatory programs such as Drinking Water. Our current process control limits are maintained in AlphaLIMS.

We also measure precision through the use of matrix duplicates and/or matrix spike duplicates. The upper and lower control limits (UCL and LCL respectively) for precision are plus or minus three times the standard deviation from the mean of a series of relative percent differences. The static precision criteria for radiochemical analyses are 0 - 20% for activity levels exceeding the contract required detection limit (CRDL).

Accuracy is measured through laboratory control samples and/or matrix spikes, as well as surrogates and

internal standards. The UCLs and LCLs for accuracy are plus or minus three times the standard deviation from the mean of a series of recoveries. The static limit for radiochemical analyses is 75 - 125%, except as specified by the Drinking Water regulations. Specific Instructions for out-of-control situations are provided in the applicable analytical SOP.

3.11 Control Charts

Per the U.S. Department of Energy, Quality Systems for Analytical Services (DOE QSAS): Control charts are a graphical representation of data taken from a repetitive measurement or process. Control charts may be developed for various characteristics, (e.g. mean, standard deviation, range, etc.) of the data. Per MARLAP "A control chart has two basic uses:

- As a tool to judge if a process was in control.
- As an aid in achieving and maintaining statistical control.

For applications related to radiation detection instrumentation or radiochemical processes, the mean (center line) value of a historical characteristic (e.g. mean detector response), subsequent data values and control limits placed symmetrically above and below the center line are displayed on a control chart."

For GEL's Chemistry, Radiochemistry, and Bioassay laboratories, the Computer Services Team (CST) developed a program where Group Leaders are sent email notifications that provide LCS failures by compound/analyte name. This assists the Group Leader with monitoring out of control situations due to laboratory contamination or analyst error. This program sends notifications once a week.

Each Group Leader may utilize programs in LIMS where they can review trending data as control charts by work order or by the SPC program.

GEL's QA Officer or designee shall review control charts during the period when the LIMS SPC program queries data points for analyses that require dynamic SPC limits for quality control parameters. This is performed on a biannual basis. At this time, any out of control conditions will be identified and a corrective action initiated. The QA Officer shall be able to stop unsatisfactory work or prevent the reporting of results generated from this program.

Dynamic SPC limits for control parameters are generally developed when more than 20 data points are available for review. Data points may be determined as outliers based on the process knowledge of the procedure being evaluated and the professional opinion of the data reviewer.

During their annual system review, management will evaluate the need to consolidate any redundant procedures and/or policies to help eliminate any confusion for work processes.

3.12 Essential Quality Control Measures

Some quality control measures are method-specific. There are, however, general quality control measures that are essential to our quality system. These quality measures include:

- Monitoring of negative and positive controls
- Defining variability and reproducibility through duplicates
- Ensuring the accuracy of test data including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, etc.
- Evaluating test performance using method detection limits and quantitation limits or range of applicability such as linearity
- Selecting the appropriate method of data reduction
- A copy of GEL's Ethics and Integrity Agreement is provided in Appendix F.

SECTION 4
FACILITIES

Section 4 - Facilities

Our laboratory is designed with a full-service approach to handling environmental needs. The layout provides dedicated space for radiochemical analyses, bioassay analysis, organic extractions, semi-volatile organic analyses, volatile organic analyses, metals analyses, general chemistry analyses, and air analyses.

The laboratory and support offices occupy approximately 85,000 square feet engineered to meet the stringent quality control and utility requirements of the modern environmental laboratory. Records are temporarily stored on-site then warehoused in a climate-controlled building off-site. The diagram in Appendix H depicts the layout of the laboratories.

Discussed in this section are:

- Facility security
- Utility services and deionized water
- Prevention of contamination
- Assessment of contamination

4.1 Facility Security

Our facility features secured laboratory and storage areas. Restricted entry assures sample integrity and client confidentiality, which satisfies clients and potential national security interests.

Visitors cannot gain entry without being escorted through the laboratory by authorized personnel. A designated sample custodian and a bar-coded chain-of-custody provide a second level of security.

4.2 Utility Services

Each defined laboratory area is equipped with the following utilities:

- Cold water
- Hot water
- Deionized water
- Compressed air
- Natural gas
- Vacuum
- 110 Volt AC
- 208 Volt AC (at selected stations)
- Specialty gases (as required)

4.2.1 Deionized Water

We have two independent deionized water (DI) systems. One serves radiochemistry while the other serves the remaining laboratories. DI water is made from city water flowing through a reverse osmosis system and a deionization system capable of producing 5 gallons per minute of Type I laboratory water.

We monitor compliance according to GL-LB-E-016 for The Collection and Monitoring of the DI Water Systems. Our monitoring activities and frequencies can be found in Table 1 of the SOP.

4.2.2 Specialty Gasses

The specialty compressed gasses may be required by specific analytical systems. Each specialty compressed gas system is monitored for background contamination that would negatively impact the efficiency of the operating system. Monitoring is generally conducted through use of routine instrument control samples which are introduced to the operating system prior to instrument calibrations and throughout the analytical process. Requirements for the purity of the gasses are identified in the instrument operating manuals and standard operating procedures.

4.3 Prevention of Contamination

Work areas that are free of sample contaminants, constituents and measurement interferences are important to the generation of quality data. With this in mind, we designed our laboratories to prevent contamination and reinforce this design with good laboratory practices.

In addition to keeping our work areas free of dust and dirt accumulations, policies and features that prevent or minimize contamination include:

- An air conditioning system that controls the environment of individual laboratories for optimum performance of sensitive instruments and to eliminate potential cross contamination.
- Segregation of volatile and semi-volatile laboratories to minimize potential contamination associated with the use of commonly required solvents.

- Negative and positive pressure air locks to isolate selected laboratories to prevent the entry of airborne contaminants.
- Fume hoods to remove fumes and reduce the risk of aerosol and airborne contaminants and personal safety hazards are monitored in accordance with GL-FC-E-003 forLocal Exhaust Ventilation Systems.
- Restricted access to the volatiles laboratory (authorized personnel only).
- Designated area for glassware preparation wherein all glassware used in sample prep and analysis is cleaned according to GL-LB-E-003 for Glassware Preparation.
- Segregated storage areas for volatiles and radioactive samples.
- Production, use, and monitoring of Type I DI water.
- Tracking and trending of any significant sample and/or reagent spills using the AlphaLIMS NCR system, allowing efficient analysis of any potential contamination.

4.4 Assessment of Contamination Levels

We evaluate contamination resulting from the following sources on the basis of quality assurance and quality control data derived from the analytical method and method blanks.

- Sample containers
- Reagent water
- Reagents and solvents
- Sample storage
- Chemical and physical interference
- Constituent carryover during analysis

Contamination in each of the volatile storage coolers is monitored by the weekly analysis of water blanks. Two DI water blanks are placed in each monitored cooler at the beginning of each month with one being analyzed each week. If the concentration of any target analyte exceeds the PQL, this is verified (with the second blank for that week) and corrective action is implemented to eliminate the source of contamination, evaluate the effect of samples stored in the cooler, and to notify clients. SOP GL-OA-E-058 discusses these practices in detail.

SECTION 5
EQUIPMENT AND REFERENCE MATERIALS

Section 5 - Equipment and Reference Materials

GEL's ability to efficiently generate data that are reproducible, accurate, and legally defensible is attributable to our use of high-quality instruments, equipment, and reference materials.

Provided in this section are:

- GEL's policies governing instruments, equipment, and reference materials
- Identification of instrumentation and support equipment
- Procurement protocol

5.1 General Policies

It is our policy to purchase instrumentation, equipment and high-quality reference materials that meet or exceed the method and regulatory requirements for the analyses for which we are accredited. If we need to use instruments or equipment not under our permanent control, we ensure that it also meets these standards.

Instrumentation and equipment are placed into service on the basis of ability to meet method or regulatory specified operating conditions such as range and accuracy. All laboratory instrumentation and testing equipment is maintained in accordance with standard operating procedures (SOPs).

Instrumentation and equipment is used in a manner that assures, where possible, that measurement uncertainty is known and consistent with specified quality requirements. Instruments and equipment are taken out of service and segregated or labeled as such under the following conditions:

- Mishandling and/or overloading
- Results produced are suspect
- Demonstrated defect or malfunction

Tagged or segregated instruments and equipment remain out of service until repaired and shown by test, calibration, or verification to perform satisfactorily. Instruments that are in service and normally calibrated prior to and during use are not tagged.

Each item of equipment, including reference materials is, if appropriate, labeled, marked or otherwise identified to indicate its calibration status. We maintain records for each major item of equipment, instrumentation, and all reference materials significant to quality performance. These records are often in the form of maintenance logs, which are kept in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices.

Documentation included in these records includes but is not limited to:

- Equipment name
- Manufacturer's name
- Type identification
- Serial number or other unique identification
- Date received and date placed in service (if available)
- Current location
- Condition when received (if known)
- Manufacturer's instruction, where available
- Dates and results of calibrations and or verifications
- Date of next calibration and/or verification, where written procedures do not specify frequency
- Details of maintenance carried out to date and planned for the future
- History of any damage, malfunction, modification or repair

5.2 Instrumentation and Support Equipment

Appendix G lists the instruments we use for the analysis of environmental, radiochemical and bioassay samples. Where feasible, our instruments are equipped with autosamplers that improve efficiency and facilitate consistent sample introduction to the sample detector. They are also connected to an area network to facilitate data transfer.

Devices that may not be the actual test instrument but are necessary to support laboratory operations are referred to as support equipment. We also maintain this equipment in proper working order. Support equipment utilized at GEL includes:

- balances
- ovens
- refrigerators
- freezers
- incubators
- water baths
- temperature measuring devices
- volumetric dispensing devices
- muffle furnaces
- distillation apparatus
- grinders and homogenizers
- hot plates and heating mantles
- ultraviolet sterilizers.

Guidelines for the required calibration and evaluation of this equipment are discussed in Section 7.

We perform radiochemical and bioassay analytical services in accordance with the instrumentation and reference methods approved by the Department of Energy (DOE), the Environmental Measurements Lab (EML), the Environmental Protection Agency (EPA), ASTM, and Los Alamos Health and Environmental Chemistry (LAHEC). Modifications to these methods may be appropriate as a result of Performance Based Measurement Systems (PBMS).

SOPs are used to describe our procedures for all routine analyses performed by our labs. These procedures include step-by-step instructions for sample collection, storage, preparation, analysis, instrument calibration, quality control, disposal, and data reporting.

5.3 Procurement and Control of Purchased Items

Materials, equipment, and services that affect the quality of our products are designated as Quality Materials, Equipment, and Services and are only purchased from approved suppliers. We approve and document suppliers according to GL-QS-E-001 for the Conduct of Quality Audits.

At GEL, we maintain documentation of specific quality requirements for Quality Materials and Services. Records that document the quality of a product or service may include:

- certificates of analysis and traceability
- verifications of chemical quality
- inspections of equipment or materials
- verifications or inspections of vendor product specifications

Our procedure for requisitioning supplies, instruments, equipment and other common use material is described in GL-RC-E-002 for Material Requisition. These requests typically include:

- The date and name of person(s) requesting materials
- Account, department, project number to which the material is to be billed
- Recommended supplier or vendor
- Additional information necessary to expedite the purchase request
- Specifications that could affect the quality of products and services
- Vendor's material part number
- Amount of material needed
- Description of material
- Cost per unit
- Person(s) authorizing the purchase
- Time frame in which the material is needed

The equipment, instruments, and reference materials we purchase are inspected upon receipt in accordance with GL-RC-E-001 for the Receipt and Inspection of Material and Services. This inspection is to verify that procured items meet the acceptance criteria defined in the procurement documentation. Staff performing initial inspection routinely:

- Open and inspect all items for damage
- Compare the items with the issued purchase order or contract for catalog or part number, description or procurement specification, quality requirement, and acceptance criteria
- Label items with a limited shelf life with the date received
- Determine if the items conform to the specifications agreed to by the vendor.

The individual responsible for the technical acceptance of the item provides procurement and receiving staff with the proper acceptance documentation. Items found not to conform to quality standards are returned to the supplier, identified as nonconforming or disposed according to the established procedures in GL-

QS-E-004 for AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. These nonconforming items may also include those identified as suspect/counterfeit items as identified in DOE guide DOE G 414.-3 for use with DOE 414.1B, C and D.

SECTION 6
HEALTH AND SAFETY

Section 6 - Health and Safety

GEL maintains a safe work environment and promotes healthy work practices. Our corporate Safety, Health, and Chemical Hygiene Plan was developed by a resident certified industrial hygienist. Procedures outlined in the plan are consistent with Occupational Safety and Health Administration, CERCLA, the Environmental Protection Agency, and SCDHEC.

All employees are trained in the safety practices applicable to their job functions. This training is conducted in accordance with GL-HR-E-002 for Employee Training.

Discussed in the section are:

- Fire safety and safety equipment
- Safety equipment and procedures related to handling radioactive samples

6.1 Fire Safety

Our facility is equipped with a fire alarm system designed to detect smoke in all areas of the facility. Certain high-risk areas, such as, the cold and ambient storage areas, organic sample preparation lab, hazardous waste lab, and solvent storage are additionally equipped with automatic halon systems. Fire blankets and dry chemical extinguishers are located at strategic points throughout the lab. We routinely inspect these extinguishers in accordance with GL-FC-E-004. Lab personnel are trained in the proper use and selection of fire extinguishers.

In order to decrease the risk of fire, bulk solvents are stored in a halon-protected storage room.

6.2 Evacuation

In the unlikely event of a fire (or other emergency), we have defined evacuation routes depicted in Appendix H. This diagram is posted in pertinent areas of the facility and designated staff members serve as evacuation leaders for the work groups.

6.3 Safety Equipment

Safety equipment, including safety glasses, lab coats, safety goggles, protective gloves, hard hats, and coveralls, is available to all employees as needed. We also provide respirators when needed to those who have completed training in the use of this specialized equipment.

Eyewashes and overhead showers are located throughout the laboratory. We routinely inspect these as directed in GL-FC-E-002 for Testing Emergency Eyewash and Shower Equipment.

6.4 Radiation Safety

Since GEL specializes in the handling of radioactive material, we have health physics procedures to ensure its safe handling. While lab personnel do not encounter significant levels of radiation requiring personal monitoring, a Dosimetry Program is in effect utilizing personal dosimeters for designated personnel. These dosimeters are exchanged quarterly and records of exposure are maintained. Instructions for the proper use of dosimeters are addressed in GL-RAD-S-009 for Personnel Dosimetry.

We take special precautions to ensure that samples are safely processed. Upon receipt, trained personnel use a survey meter to screen all samples for the presence of radioactivity. Protocols for the receipt of radioactive samples and for surveying suspected or known radioactive samples are detailed in GL-RAD-S-007 for Receiving Radioactive Packages and GL-RAD-S-001 for Radiological Surveys. This process is described in Section 9.

Upon leaving a radiologically controlled area, personnel check their hands and feet for potential contamination. This is done utilizing detection instrumentation that employs Geiger-Mueller or scintillation technologies. In addition, stations with portable detection instruments are set up for personnel frisking and in-process contamination surveys.

Key areas throughout the facility are surveyed:

- Laboratory analytical areas (Monthly smears)

- Radioactive Sample Storage Areas (Monthly smears and exposure rate)
- Sample Receipt and Waste Handling Areas (Monthly smears and exposure rate)
- Unrestricted and Radioactive Material Prohibited Areas (Quarterly smears)

SECTION 7
MEASUREMENT, TRACEABILITY, AND CALIBRATION

Section 7 - Traceability and Calibration

Traceability of measurements and the calibration of testing equipment are imperative to our ability to produce accurate and legally defensible data. As such, we have implemented procedures to ensure that equipment calibration and measurement verification are traceable to nationally recognized standards obtained from the National Institute of Standards and Technology (NIST) or accredited reference material producer (RMP) with traceability to NIST. Reference materials purchased outside the United States must be traceable back to each country's national standards laboratory or another national or international reference organization such as ILAC, APLAC and/or IAAC. The RMP may also have established acceptability by its approval as an ISO Guide 34 RMP. Commercial suppliers of radiochemistry reference standards/sources must conform to ANSI N42.22 and must be accompanied by a certificate of calibration consistent with ANSI N42.22-1995, section 8.

Where possible, calibration certificates provide traceability to national and/or international standards of measurement.

Calibration certificates provide measurement results and any associated uncertainty of measurement, and/or a statement of compliance with the identified specification. Calibration certifications are maintained as quality records.

When traceability to a national standard is not applicable, verification of measurement is achieved through inter-laboratory comparisons, proficiency tests, or independent analyses.

The following measurement and traceability practices are described in this section:

- Calibration criteria for support equipment
- General requirements
- Balances
- Temperature-sensitive devices and temperature monitoring
- Air displacement pipets
- Calibration criteria for instruments
- Calibration verification
- Initial calibration verification
- Continuing calibration verification

7.1 Calibration Criteria for Support Equipment

This section addresses calibration protocols for support equipment, including balances, temperature - sensitive equipment, and air displacement pipets. The general criteria applicable to the calibration of support equipment are as follows:

- Equipment is maintained in proper working order. Records of all maintenance activities including service calls are kept.
- Calibrations or re-verifications over the entire range of use, using NIST-traceable references when available, are conducted either quarterly, annually or biennially.
- The laboratory is allowed to re-verify some standards, sources and reagents to extend their expiration dates. However these reverifications must meet method acceptance criteria for their specific method and intended use. This has been GEL's process for numerous years and the laboratory has established a track record for both the reference materials and the producers. The reference materials verified/re-verified by the process have been subjected to numerous interlaboratory comparisons and cross-checked by use of different methods over a period of many years.
- If results of calibration and verification are not within the specifications for the equipment's application, then:
  1. The equipment is removed from service until repaired
  2. Under certain conditions, a deviation curve may be prepared. All measurements are corrected for the deviation, recorded and maintained.

- Prior to use each day, balances, ovens, freezers, refrigerators, incubators, and water baths are checked with NIST-traceable references (where possible) in the expected range of use.
- If prescribed by the test method, additional monitoring is performed for a device used in a critical test (such as an incubator or water bath).
- Support equipment is used only if the reference standard specifications (provided by the supplier or described in the analytical method) are met.
- Reference standards of measurement such as Class S or equivalent weights or traceable thermometers may be used for calibration when demonstrated that their performance as reference standards will not be invalidated.
    - Reference standards of measurement are calibrated by a body that can provide, where possible, traceability to a national standard.
- Reference standards and measuring and testing equipment are, subject to in-service checks between calibrations and verifications, in accordance with ANSI/ISO/IEC 17025-2005.
- Reference materials, where possible, are traceable to national or international standards of measurement, or to national or international standard reference materials.
- Mechanical volumetric dispensing devices, except Class A glassware, are checked monthly for accuracy.

7.1.1 Balances

Our balances are under a service contract for annual calibration, maintenance, and cleaning. Each balance is labeled with a serial number, service date, date of next service, and signature or initials of the service technician.

Balances are set up, calibrated, and operated in the range required by the analytical method in accordance with GL-LB-E-002 for Balances. Prior to using a balance, the analyst is responsible for checking its calibration.

Calibration and calibration verification are performed using weights that are or have been calibrated against Class S or equivalent weights. These weights are traceable to NIST and calibrated biennially by a calibration service provider that meets the requirements of the ANSI/ISO/IEC 17025-2005 standard.

Calibration and calibration verification are recorded in the electronic balance calibration logbook. If the calibration or calibration verification does not meet the specified acceptance criteria, the balance is recalibrated. If the calibration criteria are still not met, the balance is removed from service and tagged as such.

7.1.2 Refrigerators, Freezers, Incubators, Ovens, Water Baths, and Similar Devices

Careful control of temperature is often central to the production of acceptable data. Temperature excursions beyond the established limits may invalidate a procedure and the associated data. Constant monitoring in accordance with GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators, and Other Similar Devices assures us that regulatory and/or method temperature requirements are being met.

We measure temperatures with thermometers that are verified either quarterly or annually against a NIST-traceable thermometer. The NIST traceable thermometers are independently verified at least annually by a verification service that meets the requirements of the ANSI/ISO/IEC 17025-2005 standard. The protocol for thermometer verification is described in GL-QS-E-007. We monitor the temperature of the following equipment according to GL-LB-E-004:

- Refrigerators and freezers used to store samples, standards, and other temperature-sensitive materials
- Incubators
- Ovens
- Water baths

We monitor the temperatures of refrigerators and freezers prior to use on each working day. The temperatures of ovens, water baths, and other devices used as part of an analytical process must be

monitored prior to, during, and immediately after use. Incubators and other devices used for other specialized analytical methods may require more frequent monitoring as specified in the corresponding SOP.

Temperature measurements are documented on logs specific to each piece of equipment. These logs may be paper or recorded electronically in LIMS. The logs may be posted on or near each refrigerator, freezer, water bath, oven, or other temperature control device. Electonic monitoring logbooks for refrigerators, freezers, and coolers with temperature probes are found in AlphaLIMS. Each log includes the following information:

- Date and time of each measurement
- Initials of person taking measurement
- Acceptance limits for device being monitored
- Whether device conforms with specifications at time of measurement
- Name, location, and number of device being monitored
- Notation of any out-of-control condition
- Any corrective action requred

When the process to maintain and document temperatures within acceptance limits does not conform to specificationsappropriate action is then taken to document the nonconformance. according to GL-QS-E-004 for AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items. Any corrective action taken to bring the equipment back into acceptable use is discussed.

Examples of nonconformances are:

- Failure to maintain process temperature within acceptance limits
- Failure of device to achieve calibration
- Total failure of temperature control device
- Failure to monitor the temperature as required

7.1.3 Air Displacement Pipets

We calibrate air displacement pipets in accordance with GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets. As specified in the SOP, the calibration of an air displacement pipet is verified daily prior to use, based on a single point measurement.

The acceptance criteria for each measurement are based on the standard deviation of the calibration measurements. Tolerance limits for commonly used verification volumes and accuracy and precision checks are included in the pipet calibration logbook. Calibrations and daily calibration verifications are traceable to each pipet using the unique identification found on its label.

If a pipet does not meet the calibration tolerance limits, it is removed from service until it again demonstrates compliance after being cleaned and/or repaired. Analysts whose jobs may require the use of air displacement pipets are trained in their proper use and calibration.

7.2 Instrument Calibrations

To ensure that the data generated by an instrument are accurate, we calibrate the instrument using standards containing known concentrations of target analytes. We verify the accuracy of calibration standards by analyzing an additional standard containing the target analytes. This initial calibration verification standard (ICV) originates from a second source. Verification that the instrument response is reliable and has not changed significantly from the current calibration curve is accomplished by the analysis of a continuing calibration verification (CCV) standard. Some analytical methods employ the use of CCVs at varying concentrations.

Traceability of calibration, calibration verification, and other quality control standards to the recognized standard is documented per GL-LB-E-007 for Laboratory Standards Documentation. Preparation and Verification of Radioactive Standards is described in GL-RAD-M-001. Individual identification numbers are assigned to each source standard and each subsequent intermediate and working standard prepared.

The identification number makes it possible to trace a standard to a parent standard and ultimately to the source standard. The date each standard is prepared, the protocol used in the preparation, the person preparing the standard, and the standard's expiration date are documented in the appropriate standards log, usually maintained in AlphaLIMS. The information is accessible via the standard ID number.

We record standard and reagent ID numbers on instrument run logs, analytical logbooks, sample preparation logs, and instrument raw data. Calibration standards that are used in the analysis of a particular sample or group of samples can be traced to NIST, US EPA, or other nationally recognized standards.

Calibration procedures for specific instruments, and the frequencies of performance for defined methods, are described in the applicable operating or analytical SOP. Calibration is discussed in general terms in GL-QS-E-014 and includes standard laboratory practices and formulas used for determinations made by these practices. General guidelines include:

- Verification of initial calibrations with a standard obtained from a second source (unless one is not available).
- Analysis of verification standards (ICV and CCV) with each initial calibration within 15% of the true value unless historical data have demonstrated that wider limits are applicable.
- Preparation of calibration curves as specified in the reference method.

If a test method does not specify the number of calibration standards, the minimum number is two, not including blanks, with one at the lowest quantitation limit. The reference SOP must establish the initial calibration requirements. DOE/DoD QSM projects have additional requirements as discussed in GL-QS-B-002.

7.3 Calibration Verification

Unless otherwise specified by the method, regulatory program or demonstrated through historical data, the recovery of target analyte(s) in calibration verification standards shall be between 85 - 115%. We discuss additional requirements below.

7.3.1 Initial Calibration Verification (ICV)

- If an initial calibration curve is not established on the day of analysis, the integrity of the curve should be verified each day of use or every 24-hour period. Verification requires the initial analysis of a blank and standard from a second source. The standard concentration should be at the method-defined level. If not specified, a standard at a mid-level concentration may be used.
- If the initial calibration verification does not meet acceptance criteria, the analytical procedure is stopped and evaluated, and appropriate corrective measures are taken. Initial calibration verification must be acceptable before any samples are analyzed.

7.3.2 Continuing Calibration Verification (CCV)

Additional standards called CCVs are analyzed after the initial calibration curve or the integrity of the initial calibration curve is accepted. CCVs are analyzed at a frequency of 5% or every 12 hours, whichever is more frequent. If an instrument consistently drifts outside the acceptance criteria before the next calibration, the frequency is increased.

CCVs may be from the same source as the calibration standards or from a second source. The concentration is determined by the anticipated or known concentration of the samples and/or method-specified levels. At least one CCV shall be at a low-level concentration.

To the extent possible, we bracket the samples in each interval (every 20 samples or every 12 hours) with CCV concentrations closely representing the lower and middle range of reported sample concentrations. If this is not possible, the standard calibration checks should vary in concentration throughout the range of the data being acquired.

If the recovery of a CCV does not meet the acceptance criteria and routine corrective actions fail to produce a second consecutive check within acceptance criteria, a new initial calibration curve should be constructed. Analytes of interest found in corresponding environmental samples may be reported, however, only if all of these criteria are met:

1. CCV recovery for target analyte exceeds the acceptance criteria (biased high)
2. Target analyte in the environmental sample is not detected at a concentration exceeding the level required by client contract (i.e., MDL, PQL).

   Non-detects that meet these criteria are also referred to as "passable non-detects."

If samples are found to contain target analytes that exceed the associated quantitation limits, and the CCV recovery does not meet the acceptance criteria, the

affected samples are re-analyzed. This occurs only after a new calibration curve has been established, evaluated, and accepted.

7.4 Bioassay Instrument Calibration and Frequency

Our Bioassay instruments are calibrated at the frequency of the instrument's use, stability, and method requirements. The calibration procedure for each instrument is described in the corresponding analytical SOP and is performed by those individuals proficient in the analyses described in the SOP.

SECTION 8
ANALYTICAL METHODS AND STANDARD OPERATING PROCEDURES

Section 8 - Analytical Methods and Standard Operating Procedures (SOPs)

We provide a wide array of parameters including volatile organics, extractable organics, metals, general inorganic/wet chemistry, radiochemistry, and radiobioassay. The procedures we use to determine these parameters are consistently executed due to our extensive system of SOPs and our training requirements for analytical staff.

A list of our SOPs and the analytical methods they represent (if applicable) is provided in Appendix I. Discussed here are:

- Selection of analytical methods
- Standard operating procedures
- Method validation and initial demonstration of capability
- Sample aliquots
- Data verifications
- Standard and reagent documentation and labeling (Refer to Section 10.1)
- Computers and data requirements

8.1 Selection of Analytical Method

Project Managers are ultimately responsible for selecting the test codes and methods assigned to a client based on client requirements and sample collection techniques. In selecting methods, our goal is to meet the specific needs and requirements of the client while providing data that are scientifically valid.

When the use of a specific test method is mandated, only that method is used. If the analysis cannot be performed by the client-requested method, we notify the client. We do not perform method substitutions without the client's consent. We recommend that clients who submit data to regulatory agencies also obtain the agency's approval of method modifications.

When clients have specific process or reporting deviations from GEL's standard practices, the laboratory may document the deviations in contracts, case narratives and/or with specific work instructions from the Project Management Team to the laboratory. Approval of the deviations is made after consideration of all safety and quality concerns have been resolved by GEL's management.

A Project Management AlphaLIMS Manual (GL-CS-M-001) is available to assist PMs and PMAs in selecting test codes and methods and communicating the client's analytical and data reporting specifications.

8.2 Standard Operating Procedures (SOPs)

We determine each parameter by the protocol detailed in the corresponding SOP. The defined protocol originates from the analytical method or methods referenced in the SOP and may incorporate regulatory and client requirements. Descriptions of the methods we employ can be found in:

- EPA SW-846
- EPA/600/479/020
- Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC)
- American Society for Testing and Materials (ASTM)
- Standard Methods for the Examination of Water and Wastewater (SM)
- South Carolina Department of Health and Environmental Control (SCDHEC)
- Code of Federal Regulations (CFR) Titles 40 and 49
- Department of Energy Environmental Measurements Laboratory (EML)
- Los Alamos Health and Environmental Chemistry (LAHEC)
- DOE
- DoD
- HASL
- EPA CLP

In addition to these references, a number of our radiochemistry procedures were developed in conjunction with Florida State University (FSU) under the guidance of Dr. Bill Burnett.

Laboratory sections have access to GEL's SOPs to ensure that each operational system and analytical procedure is performed in a uniform manner. SOPs are controlled according to GL-DC-E-001 for Document Control and are posted on the Intranet by the Document Control Officer.

We write and issue SOPs in accordance with GL-ADM-E-001 for the Preparation, Authorization, Change, Revision, and Release of Standard Operating Procedures. A technical and/or quality review is made of each new or revised SOP prior to its implementation.

Technical reviews ensure that procedures are technically sound and method-compliant, and are conducted by a senior analyst, group leader, or data reviewer. The quality review is an independent review by a member of the Quality Systems team and ensures that the quality requirements of the method, regulatory agencies, and GEL are adequately and accurately identified.

SOPs are modified when:

- Instruments or equipment change
- An error is identified
- Improvements in technology and/or reagents need to be incorporated
- Reference methods are revised or discontinued

Proposed revisions are submitted for review on Documentation Initiation and Revision Request (DIRR) forms. Changes are not implemented without a technical and quality review.

We review our technical SOPs annually and revise them as necessary. Analytical SOPs either contain or reference other SOPs that contain:

- reference method
- applicable matrix or matrices
- method detection limit
- scope and application including parameters to be analyzed
- method summary
- definitions
- interferences and limitations
- specific safety requirements
- required equipment and supplies
- reagents and standards
- sample collection, preservation, shipment, and storage
- quality control
- calibration and standardization
- procedure
- calculations
- method performance
- pollution prevention
- data assessment and acceptance criteria for quality control measures
- corrective actions for out of control or unacceptable data
- waste management
- references
- tables, diagrams, flowcharts, validation data
- identification of any modifications we have made to the published procedure

8.3 Method Validation and Initial Demonstration of Capability

Method validation requirements for Radiochemistry are documented and maintained in accordance with GL-RAD-D-002, Analytical Methods Validation for Radiochemistry.

An initial demonstration of method performance is required before a new analytical method is implemented and any time that there is a significant change in instrumentation or methodology. Exempted from this requirement are any tests for which spiking solutions are not available. Analyses that are exempt include those for determining:

- total dissolved, total suspended, total volatile, and total solids
- pH
- color
- free liquids
- temperature
- dissolved oxygen
- turbidity

We conduct the initial demonstration as described in Section 8.3.1. Records of initial demonstration are maintained in accordance with GL-QS-E-008 for Quality Records Management and Disposition. These records are available upon request.

After we demonstrate our ability to perform a specific analysis, we continue to demonstrate method performance through the analysis of laboratory control samples and performance evaluation samples.

If spiking solutions or quality control samples are not available, an analyst is trained by a qualified trainer to conduct the analysis. Analyst capability and proficiency is evaluated by the appropriate Group Leader before the

analyst is qualified to perform the analysis on client samples. The evaluation is documented and maintained according to GL-QS-E-017 for Maintaining Technical Training Records.

8.3.1 Procedure for Initial and Continuing Demonstrations of Capability (IDOC and CDOC)

We conduct initial demonstrations of capability for mandated analytical or EPA reference test methods following the procedure outlined below. This procedure is adapted from the EPA test method published in 40 CFR part 136, Appendix A and the 2003 NELAC and 2009 TNI Standards. IDOCs are completed whenever there is a change in instrument type, method or personnel. CDOCs are updated constantly in the laboratory AlphaLIMS.

Step 1: A quality control sample is obtained from an outside source (if possible). If one is not available, the sample may be prepared internally using stock standards that are prepared independently from those used in instrument calibration. The concentration is not known to the analyst.

Step 2: The QC sample is diluted in a volume of clean matrix. Sufficient volume of the diluted QC sample is prepared so that at least four aliquots of the required method are analyzed. Alternatively, four matrix spike samples may be evaluated for levels of precision and accuracy.

Step 3: Four aliquots of the diluted quality control sample are prepared and analyzed according to the analytical test method. This may occur concurrently or over a period of days.

Step 4: With the results obtained from the analysis of the diluted QC sample, the average recovery (x) in the appropriate reporting units (such as µg/L) and the standard deviation of the population sample (n-1) (in the same units) are calculated for each parameter of interest.

Step 5: For each parameter, the standard deviation (s) and the average recovery (x) are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria. If "s" and "x" for all parameters meet the acceptance criteria, analysis of samples may begin. If any one parameter exceeds the acceptance range, the performance is unacceptable for that parameter.

Step 6: When one or more tested parameters fail one or more of the acceptance criteria, we locate and correct the source of the problem and repeat the test for every parameter of interest.

Other options for successful IDOCs are the following:

- PT Study- successful analysis of a PT Sample. The PT sample may be single-blind to the analyst or double blind to the laboratory.
- Supervised Analysis- where other options are not practical, supervised analysis of a procedure may be used to demonstrate capability.
- Analysis of authentic sample with results statistically matching those obtained by another trained analyst.
- Other – this option may be used for certain personnel having sufficient analytical skills to develop a new procedure, as deemed appropriate by the supervisor or Quality Assurance personnel.

8.4 Sample Aliquots

When obtaining aliquots from a sample, it is imperative that the subsamples be representative of the parent sample. This ensures that the results obtained from the analysis of the aliquots are representative of the entire parent sample, not just the subsample. We employ different techniques to obtain subsamples. GEL's SOP for subsampling is GL-LB-E-029.

We can obtain representative aliquots of soil samples for the determination of metals through quartering. This involves the repeated quartering of the sample until the resulting quarter is equivalent to the amount of sample needed for analysis. Quartering may not be appropriate for obtaining subsamples for volatiles or other analyses where potential contamination or loss of target analytes is a concern.

Water samples are inverted several times prior to the collection of a subsample. This ensures a thorough mix and is absolutely required for the accurate determination of analytes like total and total suspended solids.

The appropriate techniques for obtaining sample aliquots for designated analyses are discussed in the applicable SOPs.

8.5 Data Verification

All of the data we include in final reports to our clients undergoes extensive data verification. At GEL, we

have a multi-level review process that takes place in all areas of the laboratory beginning with sample login. This process and the responsibilities of each level of review are delineated in a number of procedures, including GL-GC-E-092 for General Chemistry Data Review and Packaging, GL-MA-E-017 for Metals Data Validation, and GL-RAD-D-003 for Data Review, Validation, and Data Package Assembly.

8.5.1 Sample Login:

Samples are analyzed by the methods and for the target analytes identified when samples are logged into our database. If there is an error in this entry that is not promptly identified, the incorrect analytical method may be used or certain analytes may not be determined.

To prevent this, the person who enters the information into the database is generally the client's assigned Project Manager or PM Assistant. This entered information is reviewed against the client confirmation letter and/or chain of custody. If errors are identified, they are immediately corrected.

8.5.2 Data Validation in the Laboratory

The multi-level review process in our laboratory includes initial review by the analyst, a second review by a peer, and a final review by a group leader or data reviewer. Where appropriate based on personnel and client needs, the industrial division institutes two levels of review.

Our analytical data reviews ensure that:

- The analytical procedures comply with current SOPs.
- Quality control samples are analyzed at the frequency specified in the SOP or client specifications.
- The acceptance criteria for quality control samples are met, including recoveries of matrix spikes and laboratory control samples, the relative percent difference for matrix duplicates, matrix spike duplicates, laboratory control sample duplicates, and concentrations of target analytes in the method blank.
- Instrument data, run logs, and logbooks are reviewed to ensure that all method quality control criteria were met (e.g., calibration, initial calibration verifications, and continuing calibration verifications).
- Documentation is sufficient to reconstruct the analytical procedure.
- Data are maintained according to GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices.
- Raw data are in agreement with the computer generated batch sheets and data reports.
- The calculations, dilution factors, concentration reported, and nominal concentrations are verified.
- Comments, qualifiers, or nonconformances for noncompliant or questionable data are documented.
- Data generated when the analytical process appears to be out of statistical control are not reported.

8.5.3 Validation of Data Reports and Packages

Before we report data to the client, we review the requested data report for package accuracy, completeness, and client-specifications. Responsibilities for review are dependent upon the type of report or package being generated. (Refer to Section 11 for Laboratory Report Formats.)

When a client is receiving a certificate of analysis or certificate of analysis and Quality Control Summary Report, the Project Manager (PM) or Project Manager Assistant (PMA) reviews the information for accuracy, completeness and the addition of pertinent comments made by the laboratory about the analysis or sample. The PM or PMA also reviews data for consistency as described in the Project Management AlphaLIMS Manual, GL-CS-M-001. For Bioassay results, the package is then reviewed for completeness by validator, team or group leader as described in GL-RAD-B-026.

If a client requests a case narrative, our data validators review the analyst-prepared case narrative for accuracy and to assure its consistency with the information included on the certificate of analysis and Quality Control Summary Report. If a client requests a more detailed level of data package up to and including a CLP-like package, every laboratory fraction of data is reviewed by that fraction's data validator. The data are then compiled into a final data package.

8.6 Standard and Reagent Documentation and Labeling

The documentation and labeling of standards and reagents is addressed in GL-LB-E-007 and GL-RAD-M-001 for Laboratory Standards Documentation, and in Section 10.1 of the QAP, Recordkeeping System and Design.

8.7 Computer and Electronic Data Related Requirements

Our Information Management System (IT) SOPs describe the way in which we manage our software programs and hardware systems. Control of software development and modification activities is described in GL-IT-E-003 for Requirements, Design, Operation, Validation, and Removal of Hardware and Software Systems Used by the GEL Group, Inc. All development and revision activities are validated, and revision activities are validated, verified, and controlled with revision software or other procedures prior to production use.

Analytical software that is purchased from a vendor is validated and verified in accordance with GL-IT-E-005 for Requirements, Design, Operation, Validation, and Removal of Applications Used by The GEL Group, Inc. Documentation requirements are also described in this SOP.

Electronic signature requirements for confidentiality of records are described in GL-IT-E-001 for Instrument Technology Program for Good Laboratory and Good Manufacturing Practices.

SECTION 9

SAMPLE HANDLING, ACCEPTANCE, RECEIPT, AND INTERNAL CHAIN OF CUSTODY

Section 9 - Sample Handling, Acceptance, Receipt, And Internal Chain of Custody

The way we receive and handle samples is critical to providing our clients with data that are of the highest quality and are legally defensible. We have strict policies that govern the acceptance and receipt of a sample, sample handling and integrity, maintenance of the internal chain of custody, and storage of the sample upon completion of the required analytical processes. This section describes the policies and practices that we employ, including the following:

- Agreements to perform analysis
- Proper labeling of submitted samples
- Chains of custody
- Sample receipt procedures
- Sample receipt procedures for radioactive samples
- Sample tracking
- Sample storage
- Sample disposal

9.1 Agreement to Perform Analysis

Before we accept samples, we should have an agreement with the client that specifies the analytical methods, the number of samples to be analyzed, the price for the analysis, the date by which the client must receive results, and the reporting format. Any special requirements the client may have, such as non-routine methods and reporting limits, should be part of that agreement.

An agreement to perform analysis should be in one of three forms, further detailed in our Analytical Services Reference Manual and the SOPs for Delegated Authority to Commit the Company and Request for Proposal (RFP) and Contract Review (GL-CO-E-002 and GL-CO-E-003):

- Client confirmation letter (CCL) between the client and project manager for a specific group of samples. This letter includes the cost, turn-around time, requested analysis, sample matrix, number of samples, and type of client report.
- Sample acceptance by the Project Manager from an established client based on previously agreed conditions and confirmed by the client's submission of the sample(s).
- Contractual agreement for analytical services over a designated time period or project that delineates the specifications agreed upon.
- When the laboratory agrees to perform analyses with exceptional departures from normal processes, these exceptions are clearly defined in the client-laboratory agreement.

9.2 Sample Labels and Chain of Custody Forms

Once an agreement is established, we assume joint responsibility with the client to ensure that the samples submitted are properly labeled and accompanied by full and complete documentation that includes chain of custody and, where possible, material safety data sheets. Samples that are submitted without proper documentation may be refused.

Sample labels should include the:

- client's sample identification
- location, date, and time of collection
- collector's name
- chemical preservatives used
- constituents of interest (if space permits)

When requested, we ship labeled sample containers with appropriate preservatives and a chain of custody to the client for use during sample collection. There are several advantages to using these containers, including:

- Dedication of appropriate type sample container for the intended analyte or analytical method.
- Proper sample preservation for analytical test
- Traceability of bottle lot number to the manufacturer's certification that the containers are clean and show no signs of contamination.

Chain of custody forms include the following information and are initiated at the time of sample collection:

- name and address of client
- client sample identification
- date and time of sample collection
- sample matrix

- description of sampling site location
- number of containers
- methods, chemical and physical constituents for which the analyses are to be conducted
- preservatives
- date and signature of person who collected the sample
- date of transfer and signature of person relinquishing sample to the laboratory.

When our Field Services personnel collect samples, our standard chain of custody form and certified containers are automatically used. Our standard chain of custody forms are also available to our clients and are included with each shipment of pre-labeled and preserved containers. GEL chain of custody forms should always be used unless otherwise agreed to by contract.

9.3 Sample Conditions

In addition to properly documenting sample container labels and the chain of custody form, we need to make sure that samples meet the established requirements for analytical testing. This is particularly critical for samples that are being analyzed to meet regulatory requirements.

Samples should be collected in the appropriate type of container, preserved as directed, and stored in the conditions specified in the analytical method or established regulatory guidelines. In addition, samples should be submitted with sufficient time to conduct the specified analysis within the regulatory or method holding time. Aliquots should be of sufficient volume to perform the requested analyses. A summary of these conditions and holding times for routine analyses can be found in Appendix J.

9.4 Sample Receipt

Samples submitted to us are received in a central sample receiving area by our sample custodian or login clerk. Every sample is subject to the protocols established in GL-SR-E-001 for Sample Receipt, Login and Storage.

Our sample custodian acknowledges receipt of a sample by signing the chain of custody and recording the date and time custody was transferred from the client to the laboratory. The date, time, and person receiving the sample are also recorded on a standard or client-specific Sample Receipt Review (SSR) form.

The sample custodian is also responsible for noting the condition of a sample upon its arrival. This information may be recorded on both the sample chain of custody and the Sample Review Receipt form. As detailed in GL-SR-E-001, the sample custodian should:

- Inspect all sample containers for integrity.
- Document any unusual physical damage or signs of tampering with custody seals.
- Place any samples that appear to be leaking or have unusual odor under the fume hood while notifying the responsible project manager.
- Review the chain of custody submitted by the client for completeness.
- Compare descriptions and other information on the sample container labels to that listed on the chain of custody.
- Verify the sample is within the regulatory holding time for the analyses.
- Measure and record the temperature of sample aliquots that are to be used for analyses requiring thermal preservation.
- Measure and record the pH of all sample aliquots submitted for analyses that require chemical preservation to a specific pH.
- Verify that there are adequate sample aliquots for the requested analyses.
- Verify that appropriate sample containers were used for requested analyses.

If the sample custodian discovers any abnormalities or departures from standard conditions, the PM is informed immediately. The PM will then notify the client as quickly as possible so that a decision can be made to proceed with the analysis or submit another sample or additional sample aliquots.

Common abnormalities or departures from standard conditions include:

- Sample containers with signs of damage, leaking, or tampering.

- Incomplete/missing chain of custody.

NOTE: If a nonradioactive sample has no chain of custody, the sample custodian should initiate one. "INITIATED ON RECEIPT" should be documented on the chain of custody.

- Discrepancies between the information on the chain of custody and the sample container labels.
- Method or regulatory holding time is exceeded.
- Sample is not preserved to the method or regulatory-required pH.
- The sample container does not meet method or regulatory criteria.
- The sample temperature exceeds or falls below the thermal preservation regulation or method requirement of 0° ≤ 6° C.

NOTE: If a sample is hand delivered to the laboratory immediately after collection with evidence that the chilling process has begun (arrival on ice), the sample shall be deemed acceptable.

- Radioactivity that exceeds that allowed by our radioactive license. (The handling of radioactive samples is discussed in 9.5.)

Samples that are not appropriate for the requested analyses or have no full test specifications require:

- Retention of all correspondence and records of conversations concerning the final disposition of the sample.
- Full documentation on the chain of custody and Sample Receipt Review form of the nonconforming condition and a decision to proceed with analysis.
- Documentation that the analysis is qualified appropriately on the final report.

9.5 Receipt of Radioactive Samples

The radioactive samples we receive are subject to the same monitoring identified in 9.4 when radioactivity levels do not exceed the level permitted by our license. Special procedures governing the receipt of radioactive samples are described in the GL-RAD-S-007 for the Receiving Radioactive Packages. These procedures prevent the inadvertent spread of radioactive contamination.

Because we cannot exceed the limits of our radioactive license, it is imperative that our clients notify us of impending shipments of radioactive samples. We reserve the right to refuse and return any radioactive sample where the radioactivity:

- Exceeds our permitted level by itself or in combination with other samples already on site; or
- Exceeds our administrative level of 25 mR/hr.

The following special requirements for receiving radioactive samples are applicable:

- Only designated staff trained in the proper handling of radioactive materials handle radioactive samples.
- If a sample is labeled as radioactive, the custodian will immediately inform the Radiation Safety Officer (RSO) before opening the sample.
- The radioactivity of the sample will be measured by scanning the exterior surface of the cooler using a survey meter calibrated in mR/hr. Refer to GL-RAD-S-001 for our Radiological Survey Procedures.
- If the radioactive level of the exterior of the cooler exceeds 0.5 mR/hr, the RSO will be notified before the cooler is opened.
- If the radioactivity level of a sample or group of samples is found to exceed 25 mR/hr, the RSO will be notified immediately. The client will be contacted and arrangements will be made to return the sample(s) or reduce the per sample exposure.
- If a chain of custody is not submitted with a sample, it will be placed on hold until a chain of custody is submitted.
- The inside of the cooler will be surveyed to ensure that no leakage or contamination has occurred.
- Each sample container will be surveyed and the highest reading will be documented on the Radioactive Shipment Inventory.

9.6 Sample Tracking

We track the samples we receive by a unique laboratory identification number that is automatically assigned when information pertaining to the sample is first entered into our database. Pursuant to GL-SR-E-

001, the following information is entered for each sample received:

- client and/or project code
- client sample ID
- sample matrix
- equivalent laboratory sample matrix
- type of report format specified by client
- date and time of collection
- date received
- initials of person making entries
- number of containers submitted for the sample
- requested analyses
- pertinent observations or comments affecting the sample analysis or rejection

As soon as this information is entered, AlphaLIMS automatically assigns a unique number to the sample and its containers. We use the number to track the location of a sample container and to link to any subsamples and subsequent digestates and extracts.

The unique laboratory identification number is printed on a durable barcode label that contains the client identification, sample date and time. Once labeled, the sample container's identification number is uploaded into the database by scanning the barcode. Information included in the database at the time of sample scanning is the container's storage location, bottle type and volume, physical characteristics of the bottle, preservative, and the initials of the person entering this information. Entering of this information into the database is an important part of initiating our electronic internal chain of custody.

9.7 Internal Chain of Custody

Chain of custody procedures ensure traceability and sample integrity. Our legal and evidentiary chain of custody protocol establishes a continuous record of the physical possession, storage, and disposal of sample containers, collected samples and aliquots, and sample digestates or extracts.

The internal chain of custody starts with the scanning of a container's barcode label into an electronic database while identifying the location of the sample and the person having custody, or placing the sample in a secured storage area. If we supply the containers, the chain of custody may begin when the containers are provided to the client.

With regard to the internal chain of custody, a sample is defined as being in someone's custody if:

- It is in one's actual physical possession
- It is in one's view after being in one's physical possession
- It is in one's possession and then is locked up so that no tampering may occur
- It is kept in a secured area restricted to authorized personnel only

The protocol for ensuring sample integrity using the internal chain of custody is detailed in GL-LB-E-012 for Verifying the Maintenance of Sample Integrity. The electronic internal chain of custody works in conjunction with the chain of custody submitted by the client with a sample to:

- Account for all time associated with a sample, its subsamples, and extracts or digestates from the time the sample is received at GEL to its disposal
- Identify all individuals who physically handled the sample
- Provide evidence that the sample was stored in accordance with method and regulatory protocols

The electronic internal chain of custody is stored in AlphaLIMS so that information demonstrating the proper maintenance of custody can be provided to the client on the data reports or electronic data deliverables.

9.8 Sample Storage

In order to ensure the maintenance of sample integrity, all aliquots are stored in secured areas designated for sample storage. The storage location of each sample aliquot can be tracked using the internal chain of custody. Areas designated for sample storage include:

- Main cooler where most samples requiring maintenance at a temperature range of 0° $\leq$ 6° C are stored.
- Volatile coolers for samples to be analyzed for volatile contaminants.

- Radioactive cooler for segregation of radioactive sample aliquots requiring refrigeration.
- Ambient storage for non-radioactive samples not requiring refrigeration.
- Ambient storage for radioactive samples.

The temperature of each refrigerated storage unit is monitored daily and documented per GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators Freezers, Ovens Incubators, and Other Similar Devices. In addition, the main and radioactive coolers are monitored twenty-four hours a day by temperature sensors that are connected to our main security system. If the temperatures exceed the required range, the security system notifies the facilities manager or his designee immediately. This allows corrective actions to be initiated promptly.

Prior to and immediately after analysis, samples and their digestates and extracts are stored in compliance with the requirements of the requested analytical methods and GL-SR-E-001 for Sample Receipt, Login, and Storage. If a single aliquot is supplied for analyses by several methods, the most stringent analytical storage requirements are applied to the sample.

If samples are to be analyzed for volatile organic compounds, they are stored in designated volatile coolers that are maintained at a temperature range of 0° $\leq$ 6° C. No sample aliquots are stored in these refrigerators unless they are to be analyzed for volatiles. These storage units are monitored on a weekly basis for contamination by the analysis of volatile cooler storage blanks.

At the beginning of each month, two 40 mL vials are filled with treated deionized water, which is used for volatile method blanks and placed in each monitored cooler. Each week, two vials may be analyzed by EPA 8260B and the data are reported to the Quality Department. If the analysis reveals evidence of potential contamination, appropriate corrective actions are immediately implemented. SOP GL-OA-E-058 discusses the laboratory practices pertaining to monitoring and testing for VOA contamination.

Sample aliquots for non-volatile analysis, which also should be maintained at 0° $\leq$ 6° C, are stored in the main cooler unless they are radioactive. In order to reduce the chance of contamination, radioactive samples are stored in a designated cooler.

Sample aliquots to be analyzed for biochemical oxygen demand (BOD) are also delivered to the bacteriology laboratory and stored in the designated BOD cooler. This cooler is also maintained at 0° $\leq$ 6° C. After initiation of this analysis, the sample aliquots are returned to the main cooler.

After all analyses are complete and results are submitted to the client, sample aliquots are transferred to the sample archive area. They are stored in this area until they are disposed.

Radioactive and non-radioactive samples remain segregated in archive to reduce the risk of contamination.

9.9 Sample Disposal

Our policies concerning sample disposal are described in the Laboratory Waste Management Plan, GL-LB-G-001 and can be divided into two categories: those governing the disposal of sample laboratory waste, and those governing the disposal of residual client sample after the completion of all analyses.

9.9.1 Sample Laboratory Waste

Unless otherwise requested by contract, laboratory waste is collected in designated satellite containers found in sample collection and accumulation areas. These areas are monitored by both the waste department and analysts trained in waste collection. Wastes are segregated based on the type of hazard they present. I.e. radioactive, acid, base solvent, etc. when containers are full, the waste department is notified and the containers are removed from the laboratory for disposal. Direction for disposal activities, such as packaging, shipping, and disposal site selection are provided in the Laboratory Waste Management Plan (GL-LB-G-001).

9.9.2 Residual Client Sample

Unused client sample material that is not consumed during the sample preparation or analytical procedures is either disposed of in accordance with the Laboratory Waste Management Plan (GL-LB-G-001) or at the client's request,

returned in accordance with GEL's SOP GL-SR-E-002 for Transportation and Shipping of Samples.

It is our policy to hold samples for a minimum of sixty days after invoicing and before disposal, unless otherwise specified by contract or if the sample is part of litigation. If the sample is part of litigation, disposal of the physical sample shall occur only with concurrence of the affected legal authority, sample data user, and/or client.

When sample analyses are complete and regulatory and/or contractual holding times have expired, samples are moved from their storage locations to the radioactive or non-radioactive archives. Samples that are to be returned to the client or held for an extended time period are segregated from the other samples. Radioactive and non-radioactive samples remain segregated.

When internal or client-specified storage time expires, samples with like matrices are composited into appropriate containers. The composites are then subject to the same treatment and disposal protocol. Samples that are approved for disposal are scanned into our LIMS and assigned the status of "Disposed."

SECTION 10
RECORDS

Section 10 - Records

Our quality records provide the documentation we need to support analytical results and conclusions. Documented evidence that quality assurance and quality control requirements have been met is critical to providing data that fulfill the specifications of applicable procedures, programs, and contracts.

As described in Section 3 of this Quality Assurance Plan (QAP), quality records include but are not limited to:

- Observations
- Calculations
- Calibration data
- Certificates of analysis
- Certification records
- Chains of custody
- External, supplier, and internal audits
- Run logs
- Instrument data and analytical logbooks
- Instrument, equipment and building maintenance logs
- Material requisition forms
- Monitoring logs
- Nonconformance reports
- Corrective actions
- Method development and start-up procedures including MDL studies
- Training records
- Waste management records
- Standard logs
- Software validation
- Standard operating procedures (SOPs)
- Sample collection and field data

Our procedures provide a legal and evidentiary chain of custody and are described in Section 9 of this QAP. Described in this section are:

- Record keeping system and design
- Records management and storage
- Sample handling records
- Records of support activities
- Analytical records
- Administrative records

10.1 Recordkeeping System and Design

We manage, maintain and store our quality records according to GL-QS-E-008 for Quality Records Management and Disposition. The protocols established in this document work in conjunction with those for specific types of records addressed in other SOPs to govern our record keeping system. Our record keeping system allows the historical reconstruction of all laboratory activities that produced analytical data.

We facilitate historical reconstruction by maintaining the following records and information, from the time a sample is received until it is disposed.

- A master list of all employee signatures and initials is maintained in Human Resources. This allows the identification of any GEL personnel who accept, handle, analyze, prepare, review, store, or dispose of a sample, its subsamples, associated data and reports, and other related documentation.
- If we provide bottles and containers to a client or sampling personnel, these records are kept in accordance with GL-SR-E-002 Transportation and Shipping of Sample and Pre-preserved Sample Containers. These electronic and paper records include:
  - Supplier and lot numbers of containers and/or bottles provided
  - Certifications that the containers are free of contaminates that may bias the analyses
  - Addition of preservatives and identity of person responsible for this preservation.
  - Barcode of containers supplied to a particular client or for a specific field-sampling event.

The person or agency responsible for collecting a sample is documented on the chain of custody and entered into AlphaLIMS. Other records supporting the acceptance of a sample include:

- Date and time of sample receipt

- Person accepting sample
- Condition of sample upon receipt
- Client-confirmation letter and/or sample quote
- Client chain of custody
- Electronically generated sample ID numbers specific to each sample aliquot and linked to the client's sample description, sample collection and receipt information, and analyses to be performed.
- Identification of each person who has custody of a sample, its subsamples, extracts, or digestates. (This is provided through the internal chain of custody procedures described in Section 9.)

Documentation that materials purchased for use in the analysis or preparation of samples meet specifications is maintained in accordance with GL-RC-E-001 for Receipt and Inspection of Material and Services.

Records of equipment calibrations are maintained and traceable by date and ID number to a specific analysis. These records include certifications of calibration and service that have been initialed or signed.

Our thermometers are verified against a NIST traceable thermometer and records of this verification are maintained as described in GL-QS-E-007 for Thermometer Verification. Records of the daily and monthly calibration verifications of our analytical balances are kept in accordance with GL-LB-E-002 for Balances. The calibration records for our air-displacement pipets are maintained in pipet calibration logs specific to each pipet according to GL-LB-E-010 for Maintenance and Use of Air Displacement Pipets.

When methods and/or regulations specify that samples, subsamples, extracts, and/or digestates be stored at designated temperatures, or when the method, itself, has temperature sensitive steps, we document those temperatures on monitoring logs at the frequency defined in the corresponding SOPs. We can trace the specific storage location of a sample through the internal chain of custody.

We require that the initials of all personnel responsible for monitoring temperatures be recorded in the temperature monitoring logs pursuant to GL-LB-E-004 for Temperature Monitoring and Documentation Requirements for Refrigerators, Freezers, Ovens, Incubators and Other Similar Devices. The logs are reviewed for completeness in accordance with GL-QS-E-005 for Review of Monitoring Device Logs.

Documentation on the instruments and equipment used for the analysis of samples is recorded in run logs, laboratory logbooks, instrument data and/or sample preparation logs. Routine or corrective maintenance that is performed on equipment or instruments is recorded in the maintenance log specific to the instrument. We document these records in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices.

The standards containing known quantities of target analytes that we use in instrument calibration, calibration verification, and as quality control samples, such as matrix spikes and laboratory control samples, are documented according to GL-LB-E-007 and GL-RAD-M-001 for Laboratory Standards Documentation. These records contain the following information.

- Protocol by which each standard was prepared
- Traceability of each child standard to its parent
- Date each standard was prepared
- Initials of person preparing the standard
- Expiration dates
- Concentration of each standard

This information allows us to document that the standards used were prepared in accordance with the established protocol, produced using source standards that meet the method and regulatory criteria, and used prior to their expiration date.

If required, reagents used in the preparation, dilution, and analysis of samples are verified to be free of interferences or target analytes. We record these verifications in the Reference Material in LIMS in accordance with GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices.

Analytical and sample preparation methods applied to each sample aliquot are documented via the internal chain of custody, method information, and information recorded in lab notebooks, sample preparation logs, run logs, and instrument data. The laboratory protocol we employ during analysis is dictated by the SOP in effect at the time the sample was analyzed or prepared by a specific method.

Run logs, laboratory notebooks, instrument data and sample preparation logs are used to document the preparation and analysis of samples and the associated instrument calibrations. These logs and notebooks are governed by GL-LB-E-009 for Run Logs and GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices. As stated in these SOPs, sample preparation and analytical records that are not electronically generated should be:

- Legible
- Recorded in permanent ink
- Corrected using one line marked through the error, initialed and dated
- Initialed by the responsible party

We maintain electronic records for each analytical batch. These records include the ID numbers of each client and quality control sample prepared and/or analyzed together, the method of preparation and analysis, and the matrix of the samples included in the batch.

Through our electronic statistical process control system (SPC), the acceptance criteria applied for all quality control (QC) samples are stored and maintained. The acceptance limits for target analytes are method, matrix, and time-period specific, which allow us to regenerate the criteria applied to QC samples associated with identified client samples.

Our Quality Systems Team maintains the records of nonconformances and corrective actions associated with specific samples, batches, and processes. We maintain these records according to GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items; and GL-QS-E-002 for Conducting Corrective/Preventative Action and Identifying Opportunities for Improvement.

Electronic data records are maintained in a secured database designed to protect the integrity of the data. Data that are uploaded directly from instruments and that are manually entered are backed up by a second system.

Permanent records of electronic data deliverables are maintained along with the corresponding sample preparation and analytical data review records. This documentation includes the initials of the reviewer and date of the review.

Records of the data we report to our clients are maintained in a manner that protects client confidentiality, as well as any potential national security concerns. These records include copies of certificates of analysis, quality control summary reports, case narratives, CLP forms, and other information we provided to the client. The copies may be paper or electronic. The majority of the data packages submitted to Federal clients are stored electronically prior to being submitted to the client.

Records of samples being disposed or returned to the client are documented in accordance with GL-SR-E-002 for Transportation and Shipping of Samples and Pre-Preserved Sample Containers. Such records include the date samples are returned or disposed, the destination of the samples, and name of the person transferring the samples.

10.2 Record Storage

We store quality records in compliance with GL-QS-E-008 for Quality Records Management and Disposition. The records are:

- Stored in a secured area to maintain data integrity and protect client confidentiality, including any national security concerns.
- Kept in areas where they are protected from fire loss, environmental deterioration, and, in the case of electronic records, electronic or magnetic sources.
- Indexed and filed in a manner allowing for ready retrieval.

- Accessible to the client for whom the record was generated.
- Retained for an identified period of time that equals or exceeds ten years as determined by applicable law and client contract requirements.

Electronic data records are stored on compact disks.

All of the hardware and software we need to reconstruct data is maintained according to GL-IT-E-003 for Requirements, Design, Operation, Validation and Removal of Hardware and Software Systems Used by the GEL Group, Inc. Records that are stored or generated by network or personal computers have either hard copy or write-protected backup.

10.3 Sample Handling Policy

Records of all procedures applicable to samples are maintained in our possession. These records include documents that pertain to:

- Preservation, including sample container and holding time
- Sample identification, receipt, acceptance or rejection, and login
- Sample storage and tracking including shipping receipts, transmittal forms, routing and assignment records
- Sample preparation (ID codes, cleanup and separation protocols, volumes, weights, instrument printouts, meter readings, calculations, reagents)
- Sample analysis
- Standard and reagent origin, receipt, preparation, and use
- Equipment receipt, use, specification, operating conditions and preventative maintenance
- Instrument calibration frequency and acceptance criteria
- Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions
- Method performance criteria including expected quality control requirements
- Quality control protocols
- Electronic data security, software documentation and verification, software and hardware audits, backups and records of any changes to automated data entries
- Automated sample handling systems
- Disposal of hazardous samples

10.4 Records of Laboratory Support Activities

In addition to sample handling records, we maintain the following:

- Original raw data for calibrations, samples and quality control measures, including worksheets and data output records (chromatograms, strip charts, and other instrument readout records)
- A written description of or reference to the specific method used, including the computational steps used to translate parameter observations into a reportable analytical value
- Copies of final reports
- Archived standard operating procedures
- Correspondence relating to project-specific laboratory activities
- Corrective action reports, audits and audit responses
- Proficiency test results

10.5 Analytical Records

We document and maintain analytical records, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs according to GL-LB-E-008 for Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms, and Other Recordkeeping Devices, and GL-LB-E-009 for Run Logs.

The information that is documented in analytical records includes:

- Laboratory sample ID code
- Date and time of analysis
- Instrument ID and operating conditions/parameter (or reference to such data)

- Method of analysis
- All calculations
- Dilutions
- Initials of analyst or operator
- Units of measurement

Our policy is to produce and maintain analytical records that are:

- Accurate
- Reviewed and verified
- Legible and understandable
- Traceable and authentic to their source
- Grouped in a contemporary manner with data entered and information recorded as it is obtained

10.6 Administrative Records

A number of pertinent records are maintained by Human Resources or Quality Systems, including:

- Staff qualifications and experience.
- Training records, including initial demonstrations of proficiency. (Refer to procedure GL-HR-E-002 for Employee Training.)
- A log of names, initials and signatures for individuals having responsibility for initialing laboratory records.

We monitor continuing demonstrations of proficiency through AlphaLIMS per GL-HR-E-002 for Employee Training.

SECTION 11
LABORATORY REPORT FORMAT AND CONTENTS

Section 11 - Laboratory Report Format and Contents

Accurate data are of little benefit to a client unless they are reported in a format that is easy to interpret and provides all pertinent information relating to the analysis of a sample. At GEL, we have developed certificate of analysis report formats that meet the different needs of our clients, yet provide all of the information necessary to satisfy regulatory requirements while allowing for the interpretation of the data. Each format provides accurate, clear, unambiguous and objective data.

In addition to a certificate of analysis, a client can request and receive an extended data package. This package may include any of the following: certificates of analysis; summaries of quality control; case narratives; instrument data; sample preparation data; measurement traceability and calibration information; and electronic data deliverables. If clients require the reporting of data following the established contract laboratory protocol (CLP), we can provide a CLP-like data package that will meet their needs.

It is important that the certificate of analysis format and data package requirements be discussed with the client prior to our acceptance of the samples. Project Managers and contract staff are responsible for establishing an agreement with the client concerning data reporting and the potential cost to the client for data packages and/or specialized reporting. Our analytical data are reported to three significant figures unless otherwise required by client contract.

Laboratory reports and data packages are stored and transmitted in a manner that protects client confidentiality and potential matters of national security. No reports or data packages are released to persons or organizations outside GEL without the expressed consent of the client. If directed by a regulatory agency or subpoenaed to submit documents to a court of law, we will notify the client of the demand and the records being released.

The following elements of report formats and data packages are described in this section:

- Certificates of analysis (C of A)
- Quality control summary reports (QCSR)
- Analytical case narratives
- Electronic data deliverables (EDDs)
- Types of data packages and reporting formats
- Review of data packages and reports

11.1 Certificates of Analysis

We have two primary C of A report formats, Level 1 and Level 2. Both contain the following information when applicable:

- Title
- GEL address and phone number
- Name of PM or person serving as the primary client contact
- Barcode identification of the C of A
- Number of page and total number of pages
- Name and address of client, where appropriate
- Project name or code if applicable
- Client-provided sample description
- Unique laboratory ID number for the sample
- Sample matrix
- Characterization and condition of the sample where relevant
- Date of receipt of sample
- Date and time of sample collection, if provided
- Date and time of sample analysis, reanalysis, and/or sample preparation
- Initials of analyst and person responsible for sample prep
- Analytical batch number
- Sample analysis and preparation methods (or unambiguous description of any non-standard method used)
- Reference to sampling procedure
- Additions to or deviations or exclusions from the test method, and other information relevant to a specific test, such as environmental conditions and the use and meaning of data qualifiers
- Nonconformances that affect the data
- Whether data are calculated on a dry weight or wet weight basis

- Identification of the reporting units, such as µg/L or mg/kg
- Statement of the estimated uncertainty of the test result, if applicable
- Signature and title of the person(s) accepting responsibility for the content of the C of A
- Date C of A was issued
- Clear identification of data provided by outside sources, such as air temperature or ambient water temperature
- Identification of the reporting detection limit (RDL) or practical quantitation limit (PQL) for each analyte, if applicable.

If a portion of the sample analysis is subcontracted, the C of A will identify the subcontractor or applicable accreditation number, and the data that was determined by the subcontracting laboratory

Level 2 Certificates of analysis contain the following additional information:

- Dilution factors
- Method detection limits
- Surrogate recoveries and the acceptance criteria for all organic analyses
- Estimated concentrations determined for nondetects and appropriate "U" and "J" qualifiers for nondetects and concentrations that fall between the MDL and PQL respectively.

Once issued, a C of A is not altered unless a subsequent C of A is identified as a revised report.

11.2 Quality Control Summary Report (QCSR)

We prepare and analyze samples in groups of twenty or less. The quality control data that demonstrate the sample preparation and/or analytical efficiency of the batch are summarized on a QCSR. The data reported on the QCSR may be limited to a sample delivery group contained in the batch or may include all quality control for the batch. Information reported on QCSR includes:

- Quality control sample ID number
- Type of quality control sample
- Concentrations determined, where applicable, for method blanks, matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, serial dilutions, and laboratory control sample duplicates
- Acceptance criteria for matrix spikes, matrix spike duplicates, matrix duplicates, laboratory control samples, and laboratory control sample duplicates
- Nominal concentrations of matrix spikes, matrix spike duplicates, LCSs, and LCS duplicates
- Concentration of parent sample for the matrix spikes, matrix spike duplicates, or sample duplicates
- Percent recoveries for LCS and matrix spikes
- Relative percent differences for the matrix spike duplicates, matrix duplicates, and LCS duplicates
- Analytical batch number with which the quality control data is associated
- Parent sample numbers for matrix spikes, matrix duplicates, and matrix spike duplicates
- Sample or sample delivery group ID
- Project code
- Date issued, page numbers/total number of pages
- Identification of recoveries or relative percent differences that do not meet the acceptance criteria

11.3 Analytical Case Narratives

Analytical case narratives are written by an analyst or data validator to describe the overall conditions affecting the analysis of a batch or a specific sample in the batch. Case narratives usually include:

- Sample delivery group ID number
- Analytical batch number
- Methods of preparation and analysis
- Sample matrix
- Initial of person preparing and/or reviewing the narrative
- Specific sample ID numbers
- Identification and description of batch quality control samples including parent sample identification
- Affirmation that all sample preparation conditions specified by the method or regulatory agencies were met or identification of specific deviations
- Affirmation that all analysis criteria specified by the method or regulatory agencies were met or identification of specific deviations

- Instrumentation employed if applicable and verification of its calibration
- Summary of batch quality control as compared to acceptance criteria
- Identification of nonconformances
- Pertinent comments and observations of factors that affect sample data quality

11.4 Electronic Data Deliverables (EDDs)

Electronic data deliverables are generated according to client specifications. EDDs use programs supplied by the client or created internally by our EDD team. Internally generated EDDs are usually written in Perl and/or PL/SQL.

11.5 Types of Data Packages and Reports

We offer three levels of data reports and the ability to design packages to meet the needs of our clients. The levels of data reports are summarized in Table 1.

Table 1: Data Report Formats

Level	Contents
1	Level 1 C of A
2	Level 2 C of A plus QCSR
3	Level 2 plus Case Narrative

If a client so requests, the above reports can be accompanied by EDDs, case narratives, copies of associated nonconformance reports, and other support documentation. The client's specific requirements are communicated to the laboratory and data reviewers through AlphaLIMS.

GEL's SOP GL-CS-E-002 for The Internal Review of Contractually Required Quality Criteria for Client Package Delivery defines preparation and review of the package.

If a client requests a CLP-like data package, and we agree to provide one, it is compiled in accordance with GL-LB-E-013 for CLP-Like/DOE Data Package Assembly and Revision. If a client does not request a full CLP-like data package but asks for data to be provided on CLP forms generated from software, we follow the applicable procedures in GL-LB-E-013.

11.6 Review of Data Reports, EDDs, and Data Packages

Level 1 and Level 2 data reports are reviewed for accuracy and completeness by the PM or PMA. Level 3 and CLP-like data packages are reviewed in the laboratory by a data reviewer, who is responsible for reviewing specific fractions of the data package for accuracy, consistency, and completeness in accordance with the SOP for that lab area.

No data package fraction is to be provided to the data packaging team without the approval of the appropriate data reviewer.

CLP-like data packages are reviewed in compliance with the basic protocol. Specific requirements are described in GL-LB-E-013 for the CLP-Like/DOE Data Package Assembly and Revision.

11.7 State Specific Reporting Criteria

Some state agencies require laboratories who perform drinking water analyses in support of Clean Water Act programs to communicate specific results to clients and/or agencies in some circumstances. If samples are found to contain concentrations of target analytes above those required by Federal or State regulations, the state must be informed. Please see Appendix K for state specific reporting criteria for drinking water programs.

SECTION 12

SUBCONTRACTING ANALYTICAL SAMPLES AND OUTSIDE SUPPORT SERVICES

Section 12 - Subcontracting Analytical Samples and Outside Support Services

We provide a full array of organic, inorganic, and radiochemical analyses. The subcontracting of samples to other facilities, while infrequent, may occur when:

- The client has requested analytical services for which we are not certified or do not offer as a routine product.
- The regulatory or method holding times and/or client due dates are in danger of not being met as the result of instrument malfunction or the unexpected influx of a large group of samples.

No samples are subcontracted without the client's consent. The laboratories selected to receive subcontracted samples are expected to meet the following criteria:

- Demonstrated technical capability to provide data that meet and conform to our quality standards.
- Established certification, if available, for the requested analyses.
- Successful proficiency evaluation results, if available.
- Commitment to meet time requirements for delivery of results to the client.
- Agreement to provide all documentation requested in conjunction with the analysis.
- NELAP, or ISO/IEC 17025 accreditation for the analysis if required by the client.

We audit potential subcontractors for technical and administrative compliance as directed in GL-QS-E-001 for Conduct of Quality Audits. An audit may be in the form of a book audit or an on-site review.

If there is evidence of a technical, administrative, or quality deterioration, the laboratory is removed from our list of approved subcontractor laboratories pending further evaluation, which may include an on-site audit. Once the laboratory again demonstrates compliance with GEL's standards, it can be reclassified as an approved subcontractor laboratory.

At GEL, we have a multi-faceted and trained staff. There are occasions, however, when it may be necessary to obtain the services of professionals outside of GEL. This may be due to such things as sample workload, introduction of a new instrument or method requiring special knowledge, or employee leaves of absence.

Any outside support services or service personnel are subject to the same scrutiny as a subcontract laboratory. If a service fails to meet our standards for excellence, the appropriate parties are promptly notified. If immediate corrections are not implemented and services are not of adequate quality to maintain confidence, the contract is canceled.

SECTION 13
CLIENT SATISFACTION

Section 13 - Client Satisfaction

Meeting the needs and expectations of our clients is essential to meeting our commitment to be the environmental laboratory of first choice. An important part of meeting this commitment involves receiving and resolving client concerns and complaints.

Client complaints that question the quality of laboratory data or data deliverables are directed to Quality Systems. These concerns are responded to with input from the laboratory, EDD team or data packaging group as may be needed.

The types of complaints, area(s) affected, and any impacts on quality are trended on a quarterly basis. This information is available to members of the Leadership Team and other managers and group leaders.

We use AlphaLIMS to monitor client complaints, nonconformances and corrective actions. Every complaint is entered into the system upon receipt and assigned an internal and external due date. The external due date is often established by client contract. The internal due date allows time for the Quality Systems Team to review the response and transmit it to the client on or before the due date.

If we notice a trend that significantly affects the quality of our data, a corrective action is initiated following GL-QS-E-002 for Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement. The implementation and verification of the corrective action affirms an effective and permanent solution.

The Quality Systems Team promptly audits those areas of activity or responsibility for which a complaint or concern has been stated.

APPENDIX A: REFERENCES

- National Environmental Laboratory Accreditation Program, NELAC, 2003.
- The NELAC Institute, TNI Standard, 2009.
- 10 CFR 50, Appendix B, US Code of Federal Regulations.
- 40 CFR Part 136, August 19, 2014 Guidelines Establishing Test Procedures for the Analyses of Pollutants.
- 40 CFR Part 141- National Primary Drinking Water Regulations, July 1, 2009, Subpart C-Monitoring and Analytical Requirements
- DOE Orders 414.1B 414.1C, and 414.D Quality Assurance, U.S. Department of Energy.
- EPA Requirements for Quality Assurance Project Plans (QAPPs), US EPA QA/R5.
- EPA 815-R-05-004 EPA Manual for the Certification of Laboratories Analyzing Drinking Water.
- Model Statement of Work for Analytical Laboratories, Prepared for Department of Energy NNSA Service Center by Analytical Quality Associates, Rev 7, November 2006.
- Specifications and Guidelines for Quality Systems for Environmental Data Collection and Environmental Technology Programs, American National Standard ANSI/ASQC E4-2004.
- Measurement Associated Instrument Quality Assurance for Radiobioassay Laboratories ANSI N42.23-1995.
- US Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, October, 2010.
- US Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD Version 5.0, DOE Version 3.0, July 2013.
- US Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD Version 5.1, DOE Version 3.1, January 2017
- MARLAP- Multi-Agency Radiological Laboratory Analytical Protocols
- 10 CFR Part 21- Reporting of Defects and Noncompliance
- 10 CFR Part 50 Appendix B -Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants
- 10 CFR Part 61- Licensing Requirements for Land Disposal and Radioactive Waste
- NRC REG Guide 4.15 and NRC REG Guide 4.8
- ANSI/ISO/IEC 17025-2005
- DOE G 414/1-3, 11-3-04, Suspect/ Counterfeit Items Guide for use with 10 CFR 830 Subpart A. Quality Assurance Requirements, and DOE O 414.B, Quality Assurance.

APPENDIX B: DEFINITIONS

The following definitions are used throughout the text of our Quality Systems Plan. These definitions were reprinted from "Definitions for Quality Systems," NELAC, July 1, 1999. For most entries, the original source of each definition is provided.

AlphaLIMS: GEL's Laboratory Information Management System.

Acceptance Criteria: Specified limits placed on characteristics of an item, process, or service defined in the requirement documents. (ASQC)

Accreditation: The process by which an agency or organization evaluates and recognizes a program of study or an institution as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accuracy: The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Aliquot: A discrete, measured, representative portion of sample taken for analysis. (DoD, EPA QAD Glossary)

Analyst: The designated individual who performs the "hands-on" analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Analyte: The specific chemicals or components for which a sample is analyzed; may be a group of chemicals that belong to the same chemical family, and are analyzed together. (EPA Risk Assessment Guide for Superfund, OSHA Glossary)

Analytical Detection Limit: The smallest amount of an analyte that can be distinguished in a sample by a given measurement procedure throughout a given confidence interval. (NELAC Quality Systems Committee)

Analytical Reagent (AR) Grade: Designation for the high purity of certain chemical reagents and solvents given by the American Chemical Society. (NELAC Quality Systems Committee)

Analytical Sample: Any solution of media introduced into an instrument on which an analysis is performed excluding instrument calibration, initial calibration verification (ICV), intitial calibration blank (ICB), continuing calibration verification (CCV), and continuing calibration blank (CCB)

ANSI: American National Standards Institute--this consensus standards body approves standards as a guide to aid the manufacturer, the consumer and the general public who may be concerned with its scope and provisions.

Audit: A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity. (EPA-QAD)

Batch: Environmental samples prepared and/or analyzed together with the same process and personnel using the same lot(s) of reagents. A **preparation batch** is composed of one to 20 environmental samples of the same NELAC-defined matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An **analytical batch** is composed of prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group using the same calibration curve or factor. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank: A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subject to the usual analytical and measurement process to

establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample: A subsample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process. (NELAC)

Calibrate: To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter or other device, or the correct value for each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration: The set of operations that establish, under specified conditions, the relationship between values indicated by a measuring device, or the correct value of each setting of a control knob. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve: The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their analytical response. (NELAC)

Calibration Standard: A substance or reference material used to calibrate an instrument. (QAMS)

Certified Reference Material (CRM): A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying body. (ISO Guide 30 - 2.2)

Chain of Custody: A record that documents the possession of the samples from the time of collection to receipt in the laboratory. This record generally includes: the number of and types of containers; the mode of collection; collector; time of collection; preservation; and requested analyses. (NELAC Quality Systems Committee)

Commercial Grade Items: When applied to analytical services provided to nuclear power plants licensed pursuant to 10 CFR Part 50, commercial grade item means a structure, system, or component, or part there of that affects its safety function, that was not designed and manufactured as a basic component. In the laboratory operations, commercial grade items may include calibration standards, quality control standards, reagents, instrument software conducting calculations, calibration services for support instrumentation, and other process controls, verifying their acceptability by inspections, tests, validation, or analyses by the purchaser or third-party dedicating entity (such as NIST, A2LA, NPL and TNI). This activity assures that a critical characteristic is acceptable. Commercial grade items do not include items where the design and manufacturing process require in-process inspections and verifications to ensure that defects or failures to comply are identified and corrected. These types of items are considered Consumables.

When applied to facilities and activities licensed pursuant to 10 CFR Parts 50, commercial grade item means an item that is:

(i) Not subject to design or specification requirements that are unique to those facilities or activities;

(ii) Used in applications other than those facilities or activities; and

(iii) To be ordered from the manufacturer/supplier on the basis of specifications set forth in the manufacturer's published product description (for example, a catalog).

It is the responsibility of the purchaser to identify the vendor type, grade, and use of the purchased item

Confirmation: Verification of the presence of a component through the use of an analytical technique that differs from the original test method. These may include: (NELAC)

Second column confirmation
Alternate wavelength
Derivatization
Mass spectral interpretation
Alternative detectors or
Additional cleanup procedures

Continuing Calibration Blank (CCB): Aliquot of reagent water or other blank matrix that is analyzed after each CCV. The CCB is used to determine whether the analytical sequence is in control during sample analysis.

Continuing Calibration Verification Standard (CCV): An aliquot of reagent wateror tohte blank matrix to which know quantities of the method analytes are added in the laboratory. The CCV is analytzed exactly like a sample periodically thoughout the sequence. Its purpose is to determine whether the analytical sequence is in control during the sample analysis. If may be prepared from the same source as the calibration standards and is usually of varied concentration

Control Limits: A range within which specified measurement results must fall to be compliant.

Corrective Action: Action taken to eliminate the causes of an existing nonconformity, defect, or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit: A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Exception Report (DER): An indication or judgement that a product or service has not met the requirements or the relevant specifications, contract or regulations: also a state of failing to meet the requirements.

Data Reduction: The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useful form. (EPA-QAD)

Detection Limit: The lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated degree of confidence. Refer to Method Detection Limit. (NELAC)

Document Control: The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Duplicate Analyses: The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Holding Times (Maximum Allowable Holding Times): The maximum times that samples may be held prior to analysis and still be considered valid. (40 CFR Part 136)

Initial and Continuing Demonstrations of Capability: Procedures to establish the ability of the laboratory to generate acceptable accuracy and precision which is included in many of the EPA's analytical test methods. In general, the procedure includes the addition of a specified concentration of each analyte in each of four separate aliquots of laboratory pure water or authentic samples. These are carried through the analytical procedure and the percentage recovery and the standard deviation are compared to specified limits. (40 CFR Part 136, 2003 NELAC)

Internal Standard: A known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

Initial Calibration Blank (ICB): An aliquot of reagent water or other blank matrix that is analyzed after each ICV. The ICB is used to determine whether there is carryover contamination after injection of the mid-level ICV.

Initial Calibration Verification (ICV): A solution of method analytes of know concentrations that is used to fortify an aliquot of blank or sample matrix. The ICV is obtained from a source external to the laboratory and different from the source of calibration standards. It is used to check laboratory performance with externally prepared test materials.

Instrument Performance Check Solution (IPC): A solution of one or more method analytes, surrogates, internal standards, internal standards, or other test substances used o evaluated the performance of the instrument system with respect to a defined set of criteria.

Internal Standard (ISTD): A known amount of standard added to a portion of the sample extract as a reference for evaluating and controlling the precision ans ibas of the applied analytical method.

Interferents: Substances that affect the analysis for the element of interest.

ISO/IEC 17025: The International Organization for Standardization and International E

lectrotechnical Commission form this specialized system for worldwide standardization. Members of ISO or IEC participate in the development of International Standards through technical committees established by their organization to deal with particular fields of activity. Other international organizations, government and non-government, also take part in development of these standards. The ANSI/ISO/IEC 17025-2005 is approved as an American National Standard and covers general requirements for the competence of testing and calibration laboratories.

Laboratory: A body that calibrates and/or tests.

1. In cases where a laboratory forms part of an organization that carries out other activities besides calibration and testing, the term "laboratory" refers only to those parts of that organization that are involved in the calibration and testing process.
2. As used herein, the term "laboratory" refers to a body that carries out calibration or testing at or from a permanent location, from a temporary facility, or a mobile facility. (ISO 25)

Laboratory Control Sample (LCS): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes from a source independent of the calibration standards or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias to assess the performance of all or a portion of the measurement system. (NELAC)

Laboratory Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC Quality Systems)

Limit of Detection (LOD): The lowest concentration level that can be determined by a single analysis and with a defined level of confidence to be statistically different from a blank. See also Method Detection Limit. (Analytical Chemistry, 55, p.2217, Dec. 1983, modified)

Limit of Quantitation (LOQ): The lowest concentration level of the initial calibration curve used to quantitate an analyte. (DoD clarification) The LOQ must be $\geq$ 3X the LOD, and is usually not more than 10X the LOD.

Lower Limit of Quanitiation (LLOQ): The lowest concentration at which a target analyte can be reliably measured and reported. The LLOQ is $\geq$ the lowest point in the calibration curve and represents a concentration at which both quantitative and qualitative requirements can be consistently demonstrated. The LLOQ is verified at least annually, but typically quarterly, as the LOQ verification. The verifications are performed by extracting and analyzing an LCS spiked at 0.5 to 2 times the LOQ. The LLOQ verification is carried through the same preparation and analytical procedures as envrionmental samples and QC.

Linear Calibration Range: The concentration range over which the instrument response is linear.

Matrix: The component or substrate that contains the analyte of interest. For purposes of batch determination, the following matrix types shall be used:

- ◊ Aqueous: Any aqueous sample excluded from the definition of a drinking water matrix or saline/estuarine source. Includes surface water, groundwater, and effluents.
- ◊ Drinking Water: Any aqueous sample that has been designated a potable or potential potable water source.
- ◊ Saline/Estuarine: Any aqueous sample from an ocean or estuary, or other salt-water source.
- ◊ Non-aqueous liquid: Any organic liquid with <15% settleable solids.
- ◊ Biological Tissue: Any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples shall be grouped according to origin.
- ◊ Solids: Includes soils, sediments, sludges and other matrices with >15% settleable solids.
- ◊ Chemical Waste: A product or by-product of an industrial process.
- ◊ Air Samples: Media used to retain the analyte of interest from an air sample such as sorbent tubes or summa canisters. Each medium shall be considered as a distinct matrix. (Quality Systems)

Matrix Spike (MS): Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Matrix Spike Duplicate (spiked sample/fortified sample duplicate): A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

May: Denotes permitted action, but not required action. (NELAC)

Method Blank (MB): A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples containing an analyte of interest through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit (MDL): The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater that zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136 Appendix B)

Must: Denotes a requirement that is required to be met. (Random House College Dictionary)

Negative Control: Measures taken to ensure that a test, its components, or the environment does not cause undesired effects, or produce incorrect test results. (NELAC)

NELAC: National Environmental Laboratory Accreditation Conference. A voluntary organization of state and federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of National Environmental Laboratory Accreditation Program (NELAP).

Performance Audit: the routine comparison of independently obtained quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS): A set of processes wherein the data quality needs, mandates, or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control: Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Practical Quantiation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL.

Precision: The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance, or range, in either absolute or relative terms. (NELAC)

Preservation: Refrigeration and or reagents added at the time of sample collection to maintain the chemical and or biological integrity of the sample. (NELAC)

Proficiency Test Sample (PT): A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Proficiency Testing: A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC, Section 2.1)

Proficiency Testing Program: The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results in comparison to peer laboratories and the collective demographics and results summary of all participating laboratories. (NELAC)

Protocol: A detailed written procedure for field and/or laboratory operation (e.g., sampling, analysis) that must be strictly followed. (EPA-QAD)

Pure Reagent Water: Shall be water in which no target analytes or interferences are present at a concentration that would impact the results when using a particular analytical test method. (NELAC)

Quality Assurance: An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality within a stated level of confidence. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Control: The overall system of technical activities whose purpose is to measure and control the quality of a product or service so that it meets the need of users. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Quality Manual: A document stating the quality policy, quality system and quality practices of an organization. This may also be called a Quality Assurance Plan or a Quality Plan. **NOTE:** The quality manual may call up other documentation relating to the laboratory's quality arrangements. (Quality Systems Committee)

Quality System: A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC. (ANSI/ASQC E-41994)

Quantitation Limits: The value at which an instrument can accurately measure an analyte at a specific concentration that includes the maximum or minimum levels, concentrations, or quantities of a target that can be quantified with the accuracy required by the data user. These values establish the upper and lower limits of the calibration range. (NELAC with DoD clarification)

Range: The difference between the minimum and the maximum set of values. (EPA_QAD)

Raw Data: Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies,

computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes that have been transcribed verbatim, dated and verified accurate by signature), the exact copy or exact transcript may be submitted. (EPA-QAD)

Reagent Blank (method reagent blank): A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Reference Material: A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30 -2.1)

Reference Standard: A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM - 6.08)

Relative Percent Difference (RPD): The difference between two duplicate samples, such as a MS/MSD/, LCS/LCSD, or sample/sample DUP. It is determined by taking the difference between the two results and dividing by the average.

Reporting Limit (RL): The level at which a target analyte would meet the data quality objectives of the laboratory and/or a project, which may include establishing compliance with a regulatory and/or action limit. The RL may be equal to the laboratory practical quantitation limit (PQL)

Requirement: Denotes mandatory specification; often designated by the term "shall." (NELAC)

Sample: Portion of material collected for chemical analysis, identified by a single, unique term. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis. (DoD)

Safety Related Procured Items: As specified in 10 CFR Part 50 and other Nuclear Power related activities, a basic component includes safety-related analytical services that are associated with the component information in support of an early site permit application or other safety related services identified by the client, whether the services are performed by the laboratory or others. GEL has identified the primary safety related basic component item for these services as:

- ◊ Calibration Standards for Radiochemical Analyses used in the direct issuance of analytical data reported to a Nuclear Facility. These standards are the primary sources (critical characteristic) of calibration for instruments that will provide the analytical results to our client. All Safety Related Procured Items are considered Type I procurement and must meet all specifications as identified in SOP GL-RC-E-002.

Standard Operating Procedure (SOP): A written document that details the method of an operation, analysis or action whose techniques and procedures are thoroughly prescribed and is accepted as the method for performing certain routine or repetitive tasks. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Standard Reference Material (SRM): A certified reference material produced by the U.S. National Institute of Standards and Technology and characterized for absolute content, independent of analytical test method. (NELAC)

Statistical Process Control (SPC): Statisitically derived limits that establish acceptable reanges for recoveries fo analytes of interest, including LCS, MS, MSD, PS, PSD and internal standards.

Stock Standard Solution: A concentrated solution containing one or more method analytes prepared in the laboratory using certified reference materials or purchased from a reputable commercial source.

Selectivity: The capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. (NELAC Quality Systems)

Sensitivity: The capability of a test method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC Quality Systems)

Serial Dilution: The dilution fo a sample by a known factor. When corrected by the dilution factor, the diluted sample should agree with the original undiluted sample within the specified limits. Serial dilution may reflect the influence of interferents.

Shall: Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there will be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled. (ANSI)

Should: Denotes a guideline or recommendation whenever noncompliance with the specification is permissible. (ANSI)

Spike: A known mass of target analyte added to a blank sample or subsample; used to determine recovery efficiency or for other quality control purposes.

Subsample: A portion of the entire sample randomly collected and composited to create weight used for the solvent extraction process. The saubsample should be representative of the entire sample.

Surrogate: A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes. (Glossary of Quality Assurance Terms, QAMS, 8/31/92)

Test: A technical operation that consists of the determination of one or more characteristics or performance of a given product, material equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2 - 12.4)

Test Method: An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP. (NELAC)

Tolerance Chart: A chart in which the plotted quality control data is assessed via a tolerance level (e.g. $\pm$ 10% of a mean) based on the precision level judged acceptable to meet overall quality/data use requirements instead of a statistical acceptance criteria (e.g. $\pm$ 3 sigma). (ANSI N42.23-1995, Measurement and Associated Instrument Quality Assurance for Radiochemistry Laboratories)

Traceability: The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

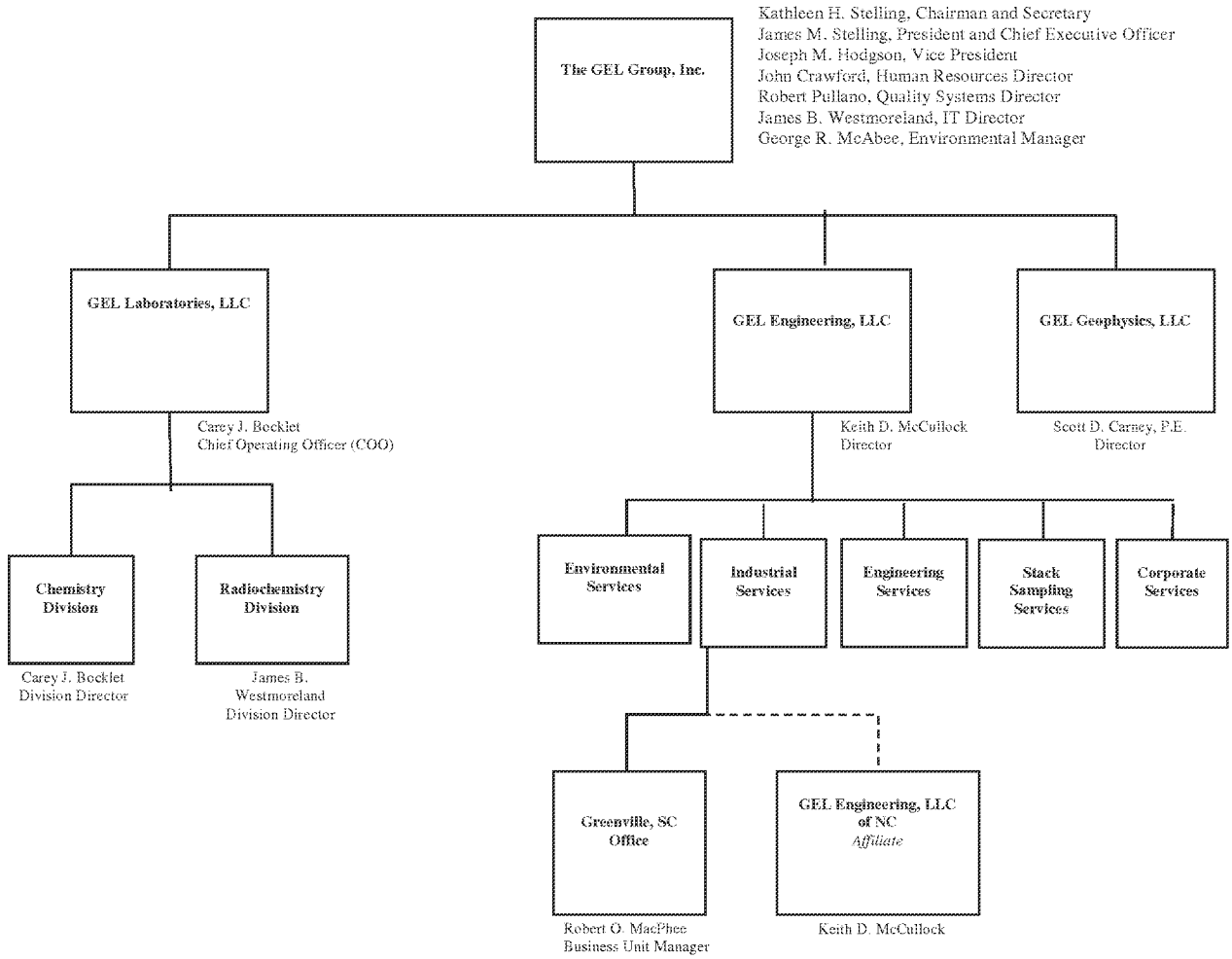
Validation: The process of substantiating specified performance criteria.

Verification: confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)

NOTE: Verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation, or specification peculiar to the management of the measuring equipment.

The result of verification leads to a decision either to restore in service, to perform adjustments, or to repair, or to downgrade, or to declare obsolete. In all cases it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.

APPENDIX C: CORPORATE ORGANIZATION CHART



APPENDIX D: CERTIFICATIONS

GEL Laboratories, LLC maintains environmental laboratory certification in many states, including primary NELAP in Utah and secondary in Florida, Illinois, Kansas, Louisiana, New Hampshire, New Jersey, New York, Pennsylvania, Texas and Virginia. We expand our list of certification as needed.

Original Scope of Accreditations are maintained in the Quality Assurance work area. Electronic copies are available in .pdf form on the GEL intranet. *Please call to confirm the status of any certification of interest to you.*

- **U.S. Department of Energy (DOE) -** Established Basic Ordering Agreement (BOA) in support of ICPT, for use by DOE and its eligible subcontractors. Audited by DOE's Office of Environmental Management under the Department of Energy Consolidated Audit Program (DOECAP)
- **Department of Defense Environmental Laboratory Accreditation Program** (DoD ELAP) through American Association for Environmental Laboratory Accreditation (A2LA) (A2LA 2567.01)
- **U.S. Department of Agriculture -** Foreign soil importation permit # P330-15-00283, P330-15-00253
- **National Environmental Laboratory Accreditation Program (NELAP) -** Primary issued through the State of Utah, Department of Health; Secondary issued through the States of Florida, Illinois, Kansas, Louisiana, New Hampshire, New Jersey, New York, Pennsylvania, Texas and Virginia
- **Clinical Laboratory Improvement Amendments (CLIA) -** U.S. Department of Health and Human Services, Certificate of Compliance for Acceptance of Human Specimens (GEL ID: 42D0904046)
- **Alaska Department of Environmental Conservation for Contaminated Sites** (GEL ID: UST-0110)
- **Arkansas** Department of Environmental Quality Laboratory Certification Program for Wastewater, Groundwater, Solid Waste Reciprocal Certification to SC DHEC (88-0651)
- **California** Environmental Laboratory Accreditation Program Certification, ELAP (GEL ID: 2940)
- **Colorado** Department of Public Health and Environment, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water Chemistry and Radiochemistry (SC00012)
- **Connecticut** Department of Public Health - Potable Water, Waste Water and/or Trade Waste, Sewage and/or Effluent, Soil and Radiochemistry Reciprocal Certification (GEL ID: PH-0169)
- **Florida** Department of Health, Bureau of Laboratories, Secondary NELAP (GEL ID E87156)
- **Georgia** Department of Natural Resources, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water (GEL ID: 967)
- **Hawaii** Department of Health, Safe Drinking Water, reciprocal to Utah NELAP, SC00012

- **Idaho** Department of Health and Welfare, SC00012
- **Illinois** EPA Environmental Laboratory Accreditation for Drinking Water, Wastewater, and Hazardous and Solid Waste, Secondary NELAP (GEL ID: 200029)
- **Indiana** State Department of Health (C-SC-01)
- **Kansas** Department of Health and Environmental Laboratory, Non-potable Water and Solid and Hazardous Waste, Secondary NELAP (GEL ID: E-10332)
- **Kentucky** Department of Environmental Protection for Drinking Water and Waste Water (GEL ID: 90129)
- State of **Louisiana** Department of Health and Hospitals (LA 170010), Safe Drinking Water, Secondary NELAP
- State of **Louisiana** Department of Environmental Quality, (03046, AI 33904), Non-drinking water, Secondary NELAP
- **Maryland** Department of Health and Mental Hygiene, Laboratories Administration, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program for Safe Drinking Water -Radiochemistry (GEL ID: 270)
- **Massachusetts** Department of Environmental Protection, Division of Environmental Analysis – Potable Water, Radiochemistry (GEL ID: M-SC012)
- **Michigan** Department of Environmental Quality – Potable Water, Radiochemistry (GEL ID: 9976)
- **Mississippi** State Department of Health NELAP reciprocity
- **Nevada** Department of Human Resources, Health Division, Bureau of Licensure and Certification, Radiologicals and Non-Radiologicals (GEL ID: SC000122016-1), Nevada Mining
- State of **New Hampshire** Environmental Laboratory Accreditation Program, Secondary NELAP (205415)
- **New Jersey** Department of Environmental Protection, Safe Drinking Water, Solid and Hazardous Waste, and Water Pollution Certification, Secondary NELAP (GEL ID: SC002)
- State of **New Mexico** Environment Department, Drinking Water Bureau, reciprocal to NELAP
- **New York** Department of Health, Environmental Laboratory Approval Program Certification, Potable Water, Non-potable Waters and Solids/Hazardous Wastes, Secondary NELAP (GEL ID: 11501)
- **North Carolina** Division of Water Quality Lab Certification Program, Waste Waters/Ground Waters. (GEL ID: 233)
- **North Carolina** Department of Health and Human Services, North Carolina State Laboratory Public Health Environmental Sciences, Safe Drinking Water. (GEL ID: 45709)
- **Oklahoma** Department of Environmental Quality, General Water Quality/Sludge Testing Laboratory Dual Certification (GEL ID: 9904)

- **Pennsylvania** Department of Environmental Protection - Bureau of Laboratories, Secondary NELAP (GEL ID: 68-00485)

- **South Carolina** Department of Health and Environmental Control - Environmental Laboratory Certification Program, Clean Water, Safe Drinking Water, Radiological, and Solid/Hazardous Wastes (GEL ID: 10120001/10120002)

- **South Carolina** Department of Health and Environmental Control (DHEC) Radioactive Material License (License #362)

- **Tennessee** Department of Health - Division of Laboratory Services, Reciprocal Certification to SC DHEC Environmental Laboratory Certification Program, Safe Drinking Water-Radiochemistry and Non-radiochemistry (GEL ID: 02934)

- **Texas** Commission on Environmental Quality, Secondary NELAP (GEL ID: T104704235-16-11)

- **Utah** Department of Health, Division of Epidemiology and Laboratory Services, Safe Drinking Water, Clean Water and Resource and Conservation and Recovery Act Certifications Primary NELAP (Customer ID: SC000122016-20)

- **Vermont** Department of Environmental Conservation, Water Supply Division, Secondary NELAP (VT87156)

- Commonwealth of **Virginia** Department of General Services - Division of Consolidated Laboratory Services, Safe Drinking Water, Clean Water Act and Resource and Conservation Act Certifications, Secondary NELAP (GEL ID: 460202)

- **Washington** State Department of Ecology, Safe Drinking Water, Clean Water and Resource and Conservation and Recovery Act Certifications (GEL ID: C780)

APPENDIX E: ESSENTIAL QUALITY CONTROL REQUIREMENTS

At GEL, we enforce strict adherence to quality control measures. Quality control measures for each type of analysis are delineated in the associated standard operating procedure and include those specified in the identified analytical method. Client requests for additional quality control agreed to by us will be communicated to the laboratory by the Project Manager and performed accordingly.

All quality control measures are assessed and evaluated on an ongoing basis. We use these measures to establish statistically derived quality control acceptance criteria. The acceptance criteria are used to evaluate whether the analytical process is in control and to assist us in establishing the validity of the data. Our procedures for handling out- of-control situations are written in the analytical standard operating procedure.

Method-specific quality measures are described in the appropriate standard operating procedure. Essential but general quality control requirements are summarized in the sections below for chemical testing, including inorganic and organic analyses, and radiochemical testing.

E1 Chemical Testing

This section includes our quality control requirements for inorganic and organic analyses, and discusses:

- Negative controls
- Positive controls
- Analytical variability and reproducibility
- Method evaluation
- Method detection limits
- Data reduction
- Quality of standards and reagents
- Selectivity
- Constant and consistent test condition

E1.1 Negative controls

We implement a negative control at least once per analytical batch of samples having the same matrix, and where, if applicable, the same extraction or preparation method is employed. The negative control is a method blank that we use to determine the presence of contamination. If discovered, we must investigate the source of contamination and take measures to correct, minimize, or eliminate the source if:

1. The concentration of target analyte exceeds the established practical quantitation limit and exceeds a concentration greater than 1/10 of the measured concentration of any sample in the analytical batch;
2. The concentration of a target analyte in the method blank exceeds that present in the samples and is greater than 1/10 of the specified regulatory limit.

If a method blank is indicative of contamination, we must assess each sample in that batch against the above criteria to determine if the data are acceptable. Any sample associated with a contaminated method blank shall be reprocessed for analysis, as needed, or we will report the results with appropriate data qualifiers.

E1.2 Positive Control - Method Performance

E1.2.1 Laboratory Control Sample (LCS)

Purpose: The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside of these criteria, indicates that the analytical system is "out of control." Any affected samples associated with an out-of-control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes, as necessary.

Frequency:	The LCS is analyzed at a minimum of 1 per preparation batch. Exceptions would be for those analytes for which no spiking solutions are available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, temperature, dissolved oxygen or turbidity. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.
Composition:	The LCS is a controlled matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes. **NOTE:** The matrix spike may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. Alternatively the LCS may consist of a medium containing known and verified concentrations of analytes or as Certified Reference Material (CRM). All analyte concentrations shall be within the calibration range of the methods. The following shall be used in choosing components for the spike mixtures: The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components the laboratory shall spike per the following: For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene, and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported. For those test methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected should be representative of all analytes reported. The following criteria shall be used for determining the minimum number of analytes to be spiked. a) For methods that include 1-10 targets, spike all components; b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater; c) For methods with more than 20 targets, spike at least 16 components. **NOTE:** Unless otherwise noted in project quality assurance plans or if components interfere with an accurate assessment, all Department of Defense projects will have LCS, MS, and MSD that contain all target analytes.
Evaluation Criteria and Corrective Action:	The results of the individual batch LCS are calculated in percent recovery. The laboratory shall document the calculation for percent recovery. The individual LCS is compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory determines internal criteria or utilizes client specified assessment criteria. An LCS that is determined to be within the criteria effectively establishes that the analytical system is in control and validates system performance for the samples in the associated batch. Samples analyzed along with a LCS determined to be "out of control" should be considered suspect and the samples reprocessed and re-analyzed or the data reported with appropriate data qualifying codes as necessary.

E1.2.2 Sample Specific Controls

The laboratory must document procedures for determining the effect of the sample matrix on method performance. These procedures relate to the analyses of matrix specific Quality Control (QC) samples and are designed as data quality indicators for a specific sample using the designated test method. These controls alone are not used to judge laboratory performance. Examples of matrix specific QC include: Matrix Spike (MS); Matrix Spike Duplicate (MSD); Post Spike (PS) and Post Spike Duplicate (PSD) sample duplicates; and surrogate spikes.

E1.2.3 Matrix Spike; Matrix Spike Duplicates, Post Spike ; Post Spike Duplicates:

Purpose: Matrix specific QC samples indicate the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information from these controls is sample/matrix specific and would not normally be used to determine the validity of the entire batch.

Frequency: The frequency of the analysis of matrix specific samples shall be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the required mandated test method.

Composition: The components to be spiked shall be as specified by the mandated test method. Any permit specified analytes, as specified by regulation or client requested analytes shall also be included. If there are no specified components, the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen using the following criteria for choosing the number of analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a 2-year period.

a) For methods that include 1-10 targets, spike all components;
b) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;
c) For methods with more than 20 targets, spike at least 16 components.

Evaluation Criteria and Corrective Action: The results from matrix spike/matrix spike duplicate and post spike/post spike duplicate are primarily designed to assess the precision and accuracy of analytical results in a given matrix and are expressed as percent recovery (%R) and relative percent difference (RPD).

Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory should determine internal criteria and document the method used to establish the limits. For matrix spike or post spike results outside established criteria, corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.4 Matrix Duplicates:

Purpose: Matrix duplicates are defined as replicate aliquots of the same sample taken through the entire analytical procedure. The results from this analysis indicate the precision of the results for the specific sample using the selected method. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.

Frequency: The frequency of the analysis of matrix duplicates may be determined as part of a systematic planning process (e. g. Data Quality Objectives) or as specified by the mandated test method.

Composition: Matrix duplicates are performed on replicate aliquots of actual samples. The composition is usually not known.

Evaluation Criteria and Corrective Action: The results from matrix duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD) or another statistical treatment (e. g., absolute differences). The laboratory shall document the calculation for relative percent difference or other statistical treatments.

Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits. For matrix duplicates results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

E1.2.5 Surrogate Spikes:

Purpose	Surrogates are used most often in organic chromatography test methods and are chosen to reflect the chemistries of the targeted components of the method. Added prior to sample preparation/extraction, they provide a measure of recovery for every sample matrix.
Frequency	Except where the matrix precludes its use or when not available, or is not a method requirement, surrogate compounds are added to all samples, standards, and blanks for all appropriate test methods.
Composition:	Surrogate compounds are chosen to represent the various chemistries of the target analytes in the method. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.
Evaluation Criteria and Corrective Action:	The results are compared to the acceptance criteria as published in the mandated test method or determined using statistical process controls (SPC). Where there are no established criteria, the laboratory determines internal criteria and documents the method used to establish the limits. Surrogates outside the acceptance criteria must be evaluated for the effect indicated for the individual sample results. The appropriate corrective action may be guided by the data quality objectives or other site specific requirements. Results reported from analyses with surrogate recoveries outside the acceptance criteria include appropriate data qualifiers.

E1.3 Method Evaluation

The following procedures, as described in the other sections of the QAP, are in place in order to ensure the accuracy of the reported result:

- Procedure for initial demonstration of analytical capability performed initially (prior to the analysis of any samples) and if there is a significant change in instrument type, personnel, matrix or test method. Refer to Section 8.
- Procedures for initial and continuing calibration protocols as specified in Section 7.
- Procedures for utilizing proficiency test samples to evaluate the ability of a procedure and/or analyst laboratory to produce accurate data as specified in Section 3.

E1.4 Method Detection Limits

Method detection limits (MDLs) are determined as described in GL-LB-E-001 for The Determination of Method Detection Limits. This procedure is based on that established in 40 CFR Part 136, Appendix B.

Where possible, MDL studies are conducted for both aqueous and solid matrices and biological tissues using a clean matrix appropriate to the test method (such as laboratory pure reagent water or Ottawa sand). MDL studies for the majority of routine parameters are conducted by:

- analyzing a minimum of seven replicates of the lowest calibration standard
- determining the standard deviation of the seven replicates
- multiplying the standard deviation by 3.143 (based on six degrees of freedom and representing a 99% confidence level) to obtain the calculated MDL.

If the MDL study is being conducted for a new method or target analyte, the following steps are taken:

- the MDL is estimated based on information provided in the method or analytical experience
- a standard with a concentration three to five times the estimated MDL is prepared and analyzed a minimum of seven times
- the MDL is calculated as above based on the standard deviation and degrees of freedom
- the MDL is evaluated for reasonableness by verification through analysis of a prepared standard solution two to three times the calculated MDL.

MDL studies are not performed for any target analyte for which spiking solutions are not available such as total volatile solids, pH, color, , temperature, dissolved oxygen, or turbidity.

Practical quantitation limits (PQLs) are determined by either multiplying the MDL by approximately 2 to 10 or are equal to that of the lowest calibration standard. Concentrations of a target analyte determined to be greater that it's PQL are defined as quantitative results. All quantitative reported results are bracketed by calibration or calibration verification standards.

All MDL studies conducted by the laboratory are submitted to the Quality Group for an independent review. Upon acceptance of the MDL study, the MDLs reported to clients via our computer system are updated unless otherwise specified by contract. PQLs are also updated as directed by the new MDLs or changes to procedures.

All data pertaining to the study and the calculation of MDLs is stored on the production file system for data packages for four years and then archived to DVD.

GEL uses an industry standard approach to establishing radiochemistry and radiobioassay MDA (minimum detectable activity). This approach is based on MARLAP guidance for posteriori determination of MDA. The approach incorporates real time events that affect the observed sensitivity for every measurement performed in the laboratory. GEL recognizes for EPA radiological drinking water samples, that a MDL study is required similar to chemical constituents tested for drinking water.

GEL will follow the source document EPA 815-R-05-004 EPA Manual for the Certification of Laboratories Analyzing Drinking Water. In Chapter VI Critical Elements for Radiochemistry, section 1.5 of this document and alternate procedure is given for radiological constituents.

The analyst should prepare and measure a sample set of at least four reagent blanks and four laboratory fortified blanks that have the radioanalyte of interest added to quantitation levels appropriate for drinking water samples, the activity level added to the laboratory fortified blanks should be between the radioanalyte's MCL and its required detection limit. To be deemed an acceptable demonstration of proficiency, the mean recoveries and the standard deviation of the recoveries of the replicate measurements should be consistent with the requirements for accuracy and precision described in Section 7.7, and reagent blank measurements must have a mean result below the detection limit for each analyte measured with the method.

E1.5 Data Reduction

The procedures for data reduction, such as use of linear regression, are documented in the individual analytical standard operating procedures. GEL's policy governing the manual integration of chromatographic data is detailed in GL-LB-E-017, Procedure and Policy for Manual Integration. Manual integrations of chromatographic peaks can only be performed in accordance with GL-LB-E-017. This ensures that the integrations are done in a consistent and technically justifiable manner while meeting the requirements set forth under the Good Automated Laboratory Practices.

SOP GL-QS-E-014, Quality Assurance Measurement Calculations and Processes, discusses the use of laboratory data in statistical determinations and includes discussion of Estimation of Total Analytical Uncertainty, Statistical Process Control (SPC) Limits, and Calibration of Instrumentation. Understanding of the procedures used for data generation and reduction is an important part of an analyst demonstrating proficiency in an analytical procedure. All

analysts and technicians responsible for generating curves and using curve-generated data are trained to this SOP per GEL annual and interim training requirements.

E1.6 Quality of Standards and Reagents

The quality of standards used in instrument calibration or quality control samples and reagents used in sample preparation and/or analysis must meet the criteria described in Section 7. In methods where the purity is not specified, analytical grade reagents are used. Reagents of lesser purity than those specified by the test method are never used. Upon receipt and prior to use, the labels on the container are checked to verify that the purity of the reagents meets the documented requirements of the particular test method.

The quality of water sources is monitored and documented as described in Section 4. The quality of water used in sample preparation or analysis meets the method-specified requirements. The type of water available in the laboratory is described in Section 4.

E1.7 Selectivity

Absolute and relative retention times aid in the identification of components in chromatographic analyses and in evaluation of the effectiveness of a column in separating constituents. The procedures governing retention time widows are documented in the applicable analytical SOP and meet all regulatory and method requirements.

In addition to retention time windows, the acceptance criterion for mass spectral training is also documented in the appropriate analytical SOP. In all cases, the acceptance criteria meet or exceed those specified in the analytical methods.

Unless stipulated in writing by the client, confirmations are performed to verify the compound identification of positive results detected on a sample from a location that has not been previously tested by our laboratory. Such confirmations are performed on a second column for organic tests such as pesticides, herbicides, or acid extractable or when recommended by the analytical test method except when the analysis involves the use of a mass spectrometer. All conformation is documented.

E1.8 Constant and Consistent Test Conditions

GEL's implementation of standard operating procedures that specify quality criteria including initial and continuing calibrations assures that our test instruments consistently operate within the specifications required of the application for which the equipment is used.

In addition to the specifications applied to instrumentation, glassware used for sample preparation or analysis is cleaned in a manner that reduces the potential for positive or negative interferences. Glassware is prepared in accordance with GL-LB-E-003 for Glassware Preparation.

This SOP details the procedures used to clean the following groups of glassware:

- That used for the determination of metals
- Reusable bottles and plasticware
- Bottles sued for the determination of biochemical oxygen demand (BOD)
- Glassware used in the determination of organic compounds
- That used for the determination of methylene blue active substances (MBAS)
- Glassware used in the determination of total organic halides (TOX)
- Glassware used in the analyses of samples for total Kjeldahl nitrogen (TKN) and total phosphorous
- Generic glassware used in all other analyses

If the method specifies that the glassware be stored in a particular manner, this requirement is documented in the appropriate analytical SOP.

Section E2 Radiochemical Analysis

This section describes the general quality control applied to radiochemical analysis. The specific quality control criteria applied to each analysis are delineated in the corresponding SOP. Detector Capabilities, Relative Bias, Relative Precision, and methods of calculating results for periodic Quality Control Determinations are discussed in the appropriate SOPs.

Discussed in this section are:

- Negative controls
- Positive controls
- Test variability/reproducibility
- Tracers and carriers
- Method evaluation
- Radiation measurement system calibration
- Data reduction
- Quality of standards and reagents
- Test conditions

E2.1 Negative Controls

Method blanks serve as the primary negative controls providing a means of assessing the existence and magnitude of contamination introduced via the analytical scheme. A method blank is analyzed at a frequency of one per preparation or analytical batch and is one of the quality control measures used to assess batch acceptance.

The activity level determined for each target in the method blank is assessed against the specific acceptance criteria specified in the applicable SOP. These criteria are based on a designated sample aliquot size and include appropriate calculations to compare the blank to activity levels determined for different sizes of sample aliquots.

The activity level of any target analyte in the method blank should be less than or equal to the contract required detection limit. The method blank may exceed this limit if the activity is less than 5% that of the lowest sample activity in the batch.

If the method blank acceptance criteria are not met, the specified corrective action and contingencies delineated in the SOPs are followed. Any failures of method blanks to meet the acceptance criteria are documented in the laboratory report and through GEL's nonconformance reporting system specified in GL-QS-E-004 for the Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.

The activity levels determined for method blanks are not subtracted from those obtained for the samples in the associated preparation or analytical batch. Correction factors such as instrument background and analyte presence in the tracer may, however, be applied to all analyzed samples including both client samples and internal quality control samples.

E2.2 Positive Controls

Positive controls routinely employed in radiochemical analyses include both laboratory control samples (LCS) and matrix spikes (MS).

The laboratory standards used to prepare LCS and MS are from a different source than those used in instrument calibration, except when the calibration has been verified with a different source. This requirement may be superseded by client specific contract requirements. The activity levels of target analytes in the LCS and MS exceed ten times the prior detection limit and are less than one hundred times this detection limit. If a radiochemical method, however, has more than one reportable analyte isotope, the LCS and MS need to only include one of the analyte isotopes.

Gamma spectroscopy is the exception to this guideline requiring the LCS and MS to contain isotopes representing the low, medium, and high-energy range of the analyzed gamma spectra.

E2.2.1 Laboratory Control Sample (LCS)

Laboratory control samples are analyzed at a minimum of once per preparation or analytical batch containing twenty or less samples.

The recovery of target analytes in the LCS is compared to the acceptance criteria specified in the applicable analytical SOP. If the recovery of the LCS does not fall within the acceptance range, the corrective actions and contingency steps specified in the SOP are implemented. These steps include the completion of an internal nonconformance report in accordance with GL-QS-E-004 and noting the failure on the laboratory report.

E2.2.2 Matrix Spike (MS)

Matrix spikes are analyzed at a minimum of once per preparation or analytical batch containing twenty samples or less under the following conditions:

- The analytical method does not utilize an internal standard or carrier
- There is a physical or chemical separation process
- There is sufficient sample volume provided for the analysis.

The target analyte recoveries are one of the quality control measures used to assess batch acceptance. The recovery of target analytes in the MS is compared to the acceptance criteria specified in the applicable analytical SOP. If the recovery of the MS does not fall within the acceptance range, the data associated with that matrix spike are qualified accordingly.

E2.3 Test Variability/Reproducibility

The reproducibility of measurements is evaluated by the use of matrix duplicates. Matrix duplicates are analyzed once per preparation or analytical batch of twenty samples. The relative percent difference (RPD) obtained between the activity levels obtained for the sample and its duplicate is evaluated against the range in the SOP.

E2.4 Tracers and Carriers

Two additional quality control measures specific to radiochemical analysis are tracers and carriers. If the analytical method requires a tracer or carrier, each sample result will be associated with a tracer recovery that is calculated and reported. For radiochemistry procedures requiring gravimetric or radiometric recovery (tracer yields), the acceptable limits are 15% - 125%. These limits may vary for specific clients and/or projects. If the applicable limits are not met, the corrective actions delineated in the SOP are implemented.

E2.5 Method Evaluation

GEL evaluates the radiochemical preparation and analytical methods to ensure the accuracy of the reported result. This evaluation includes initial demonstrations of capability as described in Section 8 and the analysis of proficiency test samples as described in Section 3. The suppliers of proficiency test samples conform to the requirements of ANSI N42.22 and ISO/IEC 17025-2005.

E2.6 Radiation Measurement System Calibration

It is not generally necessary or practical to calibrate radiochemical instrumentation each day of use due to its stability and the time-consuming nature of some of the measurements. There are, therefore, significant differences in the calibration requirements for radiochemical instrumentation from that used for chemical analyses.

Calibration differences include but are not limited to the following:

- The requirement in Section 7 for the determination of the appropriate number of standards for initial calibration is not applicable to radiochemical methods. If the radiochemical method requires multiple standards for initial calibration, the number of standards is included in the applicable SOP.

- If linear regression or non-linear regression is used to fit standard response or calibration standard results to a calibration curve, the correlation coefficient is determined. This differs from Section 7.
- The requirement identified in Section 7 for the bracketing of quantitative results by calibration or calibration verification standards is not applicable to radiochemical analyses due to the non-correlated event nature of decay counting instrumentation.
- As indicated in Section 7, the LCS may fill the requirements for the performance of an initial calibration and continuing calibration verification standard. The calibration verification acceptance criteria are the same as specified for the LCS (75 -125%).
- Background calibration measurements are made on a regular basis and monitored using control charts. These values are subtracted from the total measured activity in the determination of the sample activity. The frequency of these measurements is indicated in the SOP GL-RAD-I-010.
- Instrument calibration shall be performed with reference standards as defined in Section E3.8.
- The frequency of calibration shall be addressed in the governing SOPs.

E2.7 Data Reduction

All sources of method uncertainties and their propagation must be traceable to reported results. This is performed under the guidance of the ISO "Guide to the Expression of Uncertainty in Measurement" and the NIST Technical Note 1297 on "Guidelines for Evaluating and Expressing the Uncertainty of NIST Measurement Results." Details of calculations and equations used in reporting Radiochemistry analytical results may be found in GL-RAD-D-003 for Data Review, Validation and Data Package Assembly.

E2.8 Quality of Standards and Reagents

The reference standards we use are obtained from the National Institute of Standards and Technology (NIST), EPA, or suppliers providing NIST standards. Reference standards should be accompanied by a certificate of calibration whose content is described in ANSI N42.22 - 1995, Section 8, Certificates. All reagents used shall be analytical reagent grade or better.

E2.9 Test Conditions

GEL adheres to written procedures that minimize the possibility of cross contamination between samples. This prevents incorrect analysis results from the cross contamination. Procedures are in place, for example, to separate known radioactive and nonradioactive samples from the time of sample receipt to analysis and sample disposal.

Instrument performance checks are performed on a regular basis and monitored with control charts. This ensures that the instrument is operating properly and that the calibration has not changed. The same check source used in the preparation of the control chart at the time of calibration is used in the performance checks of the instrument. The sources must provide adequate counting statistics for a relatively short count time and should be sealed or encapsulated to provide loss of activity and contamination of the instrument and laboratory personnel.

Instrument performance checks include checks on the counting efficiency and the relationship between channel number and alpha or gamma ray energy.

APPENDIX F: ETHICS AND DATA INTEGRITY AGREEMENT

The GEL Group Inc.

ETHICS and DATA INTEGRITY AGREEMENT

I. I, (Name), state that I understand the high standards of integrity required of me with regard to the duties I perform and the data I report in connection with my employment at The GEL Group, Inc.

II. I agree that in the performance of my duties at The GEL Group, Inc.:

A. I shall not intentionally report data values that are not the actual values obtained,

B. I shall not intentionally report data that does not meet method or procedural specifications unless that data is properly qualified through comments or other notations in the analytical report.

C. I shall not intentionally report dates and times of data analyses that are not the actual dates and time of data analyses; and

D. I shall not intentionally represent another individual's work as my own.

III. I agree to inform a Group Leader, Manager, Director, or member of the Executive Committee of The GEL Group, Inc. of any accidental or intentional reporting of non-authentic data by myself or other employees in a timely manner.

IV. I will not knowingly participate in any questionable activities or violations of the Procurement Integrity Act during purchasing or sales activities. I will report any questionable activities to a Group Leader, Manager, Director, or member of the Executive Committee of The GEL Group, Inc. This includes discussions on analytical, consulting, and geophysical services pricing and contracts, vendor pricing, or other essential business information to anyone outside of The GEL Group, Inc. family.

This Ethics and Data Integrity Agreement has been explained to me by the Director of Quality Systems, my Group Leader, or at a training session, at which time I have been provided the opportunity to ask questions on any part of this agreement that I did not understand. It has also been explained to me that any violation of this agreement conducted during work performed under a subcontract or direct contract to a government agency could subject me to potential prosecution.

I understand that violation of this policy subjects me to disciplinary action, up to and including termination of my employment with The GEL Group Inc.

Employee Signature: _____ Date: _____

Trainer Signature: _____ Date: _____

APPENDIX G: EQUIPMENT LIST

List of Equipment and Instrumentation

ORGANICS EXTRACTIONS

#	Equipment	Model #	Purchase Date	ID/Serial #
3	Tekmar Sonic Distribution	600		22461D
1	J2 Scientific GPC	Accup-MP5	Jul-05	05C-1159-4-0
10	Zymark Turbovap	Turbovap II	May-96	TV9612N6726 TV9631N6975 TV9628N6939 TV9809R7994 TV0146N10597 TV0146N10596 TV0146N10598 TV0146N10595 TV1346N20168 TV1246N17453
10	Soxtherms	SOX416/SE416	Jan-05 Nov-16	4041427 4040014 4040019 4040018 SX2033 SX2050 1/846516004 1/8465160005 1/8465160006 1/8465160007

3	N-Evaps Organomation	115 1205	Jun-93 Jun-95	2812 6184 2038 11634
1	Sartorius Toploading Balance	CP 323S	N/A	19350208
1	Sartoris AG Toploading Balance	LP8200P	N/A	14908834

LIQUID CHROMATOGRAPHY/HPLC

#	Equipment	Model #	Purchase Date	ID/Serial #
4	LC/MS/MS	Quattro Ultima	May-02	D99SM9012R (LC) VB150 (MS)
		ABSCiex 4000	Sep-05	DE91608981 (LC) V04290402 (MS)
		ABSCiex 4000	Apr-07	DE43619731 (LC) V113820703 (MS)
		ABSCiex QTRAP 5500	Dec-14	L20435252316 (LC) L20435252317 (LC) AU21281403(MS)
		ABSCiex 5500	Nov-16	L20435453570(LC) L20435453571 (LC) BB214331608 (MS)
1	Shimadzu Column Heater	CTO-20AC	Dec-14	L20215251917
1	Shimadzu Degasser	DGU-20A	Dec-14	L20705263668
1	Shimadzu Column Heater	CTO-20AC	Nov-16	L20215452696
1	Shimadzu Degasser	DGU-20A	Nov-16	L20705366534
1	Aglient ALS	1100	Sep-05	DE91604756
1	Aglient Degasser	1100	Sep-05	JP13212623
1	Agilent Column Heater	1100	Sep-05	US82404465
2	LEAP Technologies PAL Autosampler	HTC-PAL	Apr-07	141417

		HTC-XT	Dec-14	326966
1	Agilent Degasser	1100	Apr-07	JP54427571
1	Agilent Column Heater	1100	Apr-07	DE11120879
1	ABSCiex PAL Autosampler	MXY013-02A	Nov-16	261775
1	Hewlett Packard Quantum Pump	1100	Oct-99	DE23919817
1	Hewlett Packard 1100 ALS	1100	Oct-99	DE91607770
1	Hewlett Packard DAD	1100	Oct-99	DE14913984
1	Hewlett Packard Degasser	1100	Oct-99	JP03925183
1	Hewlett Packard Column Heater	1100	Oct-99	US72103603
1	Hewlett Packard Quantum Pump	1100	Nov-99	DE91606066
1	Hewlett Packard ALS	1100	Nov-99	US80603453
1	Agilent HPLC with DAD and FLD	1100	Nov-99	DE54627302 DE14904242
1	Hewlett Packard Degasser	1100	Nov-99	JP63203519
1	Hewlett Packard Column Heater	1100	Nov-99	DE91609651
1	Agilent Quantum Pump	1100	Jun-05	DE33224733
1	Agilent ALS	1100	Jun-05	DE23909584
1	Agilent HPLC with DAD and FLD	1100	Jun-05	DE91608331 DE92001137
1	Agilent Degasser	1100	Jun-05	JP13211588
1	Agilent Column Heater	1100	Jun-07	DE33235932
1	Agilent Quantum Pump	1100	Jun-07	DE23919852
1	Agilent ALS	1100	Jun-07	US64401050
1	Agilent DAD	1100	Jun-07	DE43603083
1	Agilent Degasser	1100	Jun-07	JP73016466

1	Agilent Heater	1100	Jun-07	US82404303
1	OHAUS Analytical Balance	CQ10R11-2E1	N/A	00119266EK
1	Sartorius Entris Toploader	Entris 2202-1S	Jan-17	347009649

VOLATILE ORGANIC ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler (Screening Instrument)	5972	N/A	336A51009 (VOA 0)
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Oct-99	K842460828P US91911845(US00030386)VOA1
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer chemstation with 0I Eclipse/Arcon Autosampler	5973	Nov-98	G107466806P US71191097(US00023264)VOA9
1	Aglient Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Apr-09	B237010 US71191093/US00026073 VOA4
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5975	Aug-06	K736460761 US61332879(CN10848050)(VOA5)
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with 0I4560/Arcon Autosampler	5973	Jan-98	K523466628P US71191112(US00010331)VOA8

VOLATILE ORGANIC ANALYSIS

1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler	5975C	Apr-09	(E911466523P) VOA2 US83131318/CN10606080
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5973	Jul-04	M948460722 US71191113(US00028288)VOA3
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation	5977A	July-15	H352460344 US51523M408/CN15173066 VOAC
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation with OI 4560/Arcon Autosampler	5975	Sep-05	N222460467 US52430466(CN10525054)VOA6
1	Agilent Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler	5975	Apr-09	E911466524P CN10848117 (VOAA) US83131219
1	Hewlett Packard Gas Chromatograph/Mass Spectrometer Chemstation with OI Eclipse/Arcon Autosampler PID/FID Detectors	6890	June-11	US0026725 (B431466149P) (VOAB) FID=1471 PID=54500
1	Agilent Flame Ionization Detector /Chemstation with OI 4560	6890N	Aug-08	CN10813002 (VOC4)
1	OHAUS Toploading Balance	AV812N	N/A	323410747
1	Sartorius Toploading Balance	CP622	N/A	19452583

SEMIVOLATILE ORGANIC ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Agilent 6890N Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	Sep-05	CN10521005/US52440275 MSD1
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	April-09	CN10848121/US83131300 MSD2
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	April-09	CN10821032/US83131355 MSD3
1	Agilent 7890A Gas Chromatograph/ 5975C Inert Mass Spectrometer w/ 7683 Autosampler Tower	5975	Nov-07	CN10727001/US90704000 MSD4
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00023050/US82311233 MSD5
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00025502/US82311417 MSD6
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973		US70810371/US00007297 MSD7

SEMIVOLATILE ORGANIC ANALYSIS				
1	Agilent 7890 Gas Chromatograph with MMI/ 5977A Mass Spectrometer w/ 7693 Auto injector	5977A	June-15	CN15233175/US1523M414 MSDA
1	Hewlett Packard 6890 Gas Chromatograph/ 5973 Mass Spectrometer w/ 7683 Autosampler Tower	5973	May-97	US00028102/US82311616 MSD8
1	Agilent 6890N Gas Chromatograph-FID w/ CTCH5500 Headspace Autosampler	6890	July-08	CN10805007 FID8
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	March-08	CN10805005 FID6
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	June-08	CN10811015 FID7
1	Agilent 6890N Gas Chromatograph-FID w/ 7683B Autosampler	6890	July-07	US10604037 FID5
1	Hewlett Packard 6890 Gas Chromatograph-FID w/ 6890 Autosampler	6890	March-98 (Installed 4/11/2011. Old MSD2 GC)	US0009213 FID9
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	March-98	US00023402 ECD1

SEMIVOLATILE ORGANIC ANALYSIS				
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ LEAP PAL RSI Autosampler	6890	March-98	US00028911 ECD2
1	Agilent 7890A Gas Chromatograph-Dual Micro ECD w/ 7693 Autosampler	7890A	March-10 (Purchased from CFA December-11)	CN10842125 ECD3
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7673 Autosampler	6890	November-97	US00009591 ECD5
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	Nov-97	US00023343 ECD6
1	Hewlett Packard 6890 Gas Chromatograph-Dual ECD w/ 7673 Autosampler	6890	Nov-97	US00010134 ECD7
1	Agilent 6890 Gas Chromatograph-Dual ECD w/ 7683 Autosampler	6890	July-98	US10133016 ECD8
1	Agilent 7890A Gas Chromatograph-Dual Micro ECD w/ 7693 Autosampler	7890A	July-10	CN10261088 ECD9

METALS ANALYSIS

#	Equipment	Model #	Purchase Date	ID/Serial #
2	Perkin Elmer Mercury Analyzer	Fims 100 Fims 100	Apr-09 Feb-14	101S9040502 101S14020102
2	AA WINLAB (Software)	NA	Apr-09 Feb-14	NA
1	PS Analytical Atomic Fluorescence Mercury Analyzer	10.035X	Sep-11	550
1	Millennium (Software)	NA	Sep-11	NA
4	Perkin Elmer Inductively Coupled Plasma Mass Spectrometer	ELAN 9000 ELAN 9000 NexION 300 NexION 350	Apr-02 Apr-10 May-14 Aug-14	P1160304 AJ13141002 81VN4031301 85VN4061701
4	Perkin Elmer ICPMS (Software)	2.4 SP3	Apr-02 Apr-10 May-14 Aug-14	NA
4	Perkin Elmer Inductively Coupled Plasma Spectrometer	5300DV 7300DV 8300DV	Dec-07 Mar-10 Jun-10 Apr-14	077C7090601 077C0022701 077C0052701 078S1403012
4	Winlab 32 (software)	Ver 3.1.0	Dec-07 Mar-10 Jun-10 Apr-14	NA
1	Thermo Orion 3Star	3Star	Aug-09	B16666

1	Thermo Orion pH meter	420	Prior to 2008	065576
4	OHAUS Balance	AV313	Feb-08 Jan-14	8029041072 8029041075 B351136893 BB351136892
4	Sartorius Balance	U6100+ CP22025 TE313S CP 423 S	Dec-12	39010019 14509268 16107662 14910413
1	Mettler Balance	PM4600	Prior to 2008	G97859
4	TCLP Tumblers	NA	Prior to 2008	T 101 T 104 T 105 T 106
3	Environmental Express HotBlock	SC100	Prior to 2008	Various units
11	Environmental Express HotBlock	SC154	Prior to 2008	Various units
2	Torrey Pines Scientific Hotplate	HP51	Prior to 2008	08301024 08301025
1	U.S. Filter Modulab Water System	M00100	Prior to 2008	LW2264
1	Barnstead NANOpure Diamond	D11901	Aug-02	1190030186870
1	Thermo Centrifuge	CL30	Apr-08	307070484

GENERAL CHEMISTRY				
#	Equipment	Model #	Purchase Date	ID/Serial #
1	Dohrman Total Organic Carbon Analyzer	DC190	May-93	9303219
1	OI Analytical, TOC 1030S	OI1030S	Oct-15	A536733677
2	OI Analytical, TOC 1030W	OI1030W	Apr-15 Jan-16	P504730315 P550730559P
2	ATOC (software)		Apr-15	NA
2	Horizon Speed Vap II	9000 9000	Oct-01 Apr-02	01-337 01-340
2	Lachat QuikChem 8000	8000 series	Jul-01 Jul-02	A83000-1910 A83000-2077
1	Lachat QuikChem 8500	8500 series	Jan-06	60900000344
3	Omnion (software)	3.0.218 3.0.218 3.0.219	Jul-01 Jul-02 Jan-06	NA
2	ThermoSpectronic	20D+	Nov-03 Aug-06	3DUD255001 3DUJ199004
1	Mitsubishi Total Organic Halogen Analyzer	AOX-200	Jul-10	E7B00117
1	Dionex Ion Chromatograph	DX500	Oct-99	99040041
1	PeakNet (software)	5.21	Oct-99	NA

3	Dionex Ion Chromatograph	ICS-3000	Feb-08 Apr-09	07120836 09030720 09030721
1	Dionex Ion Chromatograph	ICS-5000	Jul-10	10060501
4	Chromeleon (software)	6.80 SP2	Feb-08 Apr-09 Apr-09 Jul-10	NA
1	Dionex Ion Chromatograph	ICS-1600	Jul-14	14060002
1	Chromeleon (software)	7.2.1	Jul-14	NA
1	Turbidimeter	Orion AQ4500	Feb-11	B04279
1	Mitsubishi Total Organic Halogen Analyzers	TOX-10sigma	Jul-10	75R03796
1	Titroline Karl Fischer Moisture Analyzer	D55122	Feb-07	00635172
2	TKN Block Digestor	AIM500	Feb-06	4540A10265 4540A10266
2	Lab-Line Pyro Multi-Magnestire	59380	Prior to 2008	0300-0171 0300-0170
1	YSI Dissolved Oxygen Meter	5000	Apr-15	15D100827
1	IEC Clinical Centrifuge	Clinical	Prior to 2008	428-17189
1	Pensky Martin Flashpoint Tester	HFP 380	Prior to 2008	23800146
1	Rapid Tester Setaflash	RT-00001	May-14	142271

2	Baxter TDS Ovens	DN63	Prior to 2008	DN63
2	VWR Oven	1370FM 13703M	Prior to 2008	101399
1	Vulcan Furnace	3-550PD	Apr-15	DKZ1316115V
2	HACH COD Reactor	95600-00	Jan-94	911005731C 9807000017919
1	Orion Conductivity Meter	A212	May-12	X00353
1	Parr 6200 Calorimeter	Parr 6200	Aug-14	M40303
6	Sartorius Balance	1872 ED2200S BP2100S BA210S BA221S LC8400-P	Prior to 2008	3410156 25150025 90710197 40245216 90606741 410010032
1	OHAUS Balance	PA 114	Jan-11	8331440032
1	Brookfield Viscometer	LVDVE	Apr-05	E6515383
1	PerpHect pH Meter Orion	370	Prior to 2008	19742
1	Beckman Centrifuge	TJ-6	Prior to 2008	4359
1	VWR Centrifuge	Clinical 200	Nov-11	68105001

4	Simple Cn Hotblocks	SC6002 SC6002 SC6002 SC6002	Apr-09 Apr-09 Jan-09 Jan-09	5388DIS1012 5388DIS1016 5873DIS1030 5873DIS1036
2	BOD incubator	2020 818	Jan-99 Jan-10	10059509 26AW-9
1	ManSci PC-Titrate TitraSip System	PCM-PSDT/CA	Nov-13	MT-1H3-696
1	Thermo Orion Star A111	A111	Sep-15	J10067
1	Thermo Orion Star A111	A111	Feb-14	J06078
2	Electronic Digital Caliper	Y305811 030150	Prior to 2008	62379-531 CO0130150

RADIOCHEMISTRY/BIOASSAY

#	Equipment	Model #	Purchase Date	ID/Serial #
96	Canberra Alpha Spectrometers for Alpha Spectroscopy System (environmental)	7401	1992 to 1995	Various
144	Canberra Alpha Analyst Spectrometers with PIPS Detectors (environmental)	7200	1988 to 2009	Various
144	Canberra Alpha Analyst Spectrometer with PIPS Detectors (bioassay)	7200	1988-2009	Various
1	Perkin Elmer Automatic Gamma Counter	1480	Jun-05	4800440
1	Canberra Gamma Analyst Automatic Sample Changer	GAM-AN2	Dec-06	12069216
1	Gamma Products G5400W Low background Alpha/Beta Country System with 4 detectors	G5420-400T	Jan-17	121603

4	Compaq/DEC Alpha Work Stations for Alpha/Gamma Data Management System	500AU 500AU 500AU DS-10 DS-10	Nov-98 Nov-98 Jan-04 May-06 Mar-09	N188806229 406DP9Z1060 AY93206555 AY30703843
2	Protean Automatic Proportional Counter (Bioassay)	WPC 9550	Oct-2003 Jul-2004	EMC 0329438 924233
11	Protean Multi-Detector (40) Proportional Counter	MDS-16	Apr-02 Jul-2005 Oct-05 Mar-02	10751,10752,10753,10754 0525767,0525768 0531474,0531474 311437,311438, 0021910
4	Protean Multi-Detector (16) Proportional Counter	MDS-16	Feb-09	9115168, 169, 170,171
2	Tennelec LB-4100 Proportional Counter with 32 detectors	LB4100	Jun-93 Dec-98	18483 21938
1	Tennelec LB-4100 Proportional Counter with 16 detectors	LB4100	2010	70562
1	Gas Flow Proportional Counter with 4 detectors	G5420-400T	Jan-17	121603
8	Beckman Liquid Scintillation Counters	LS6000 LS6500 LS6500 LS6000 LS6500 LS6500 LS6000 LS6000	Jun-93 Jun-93 Apr-94 Mar-03 Oct-03 Dec-98 Dec-98 Jan-14	7065155 7067083 7067404 7060655 7070506 7069123 7060656 7069693
1	Perkin Elmer Inductively Coupled Plasma Mass Spectrometer	ELAN9000	Jun-10	AJ13351006

2	Perkin Elmer Liquid Scintillation Counter – Wallac Guardian (environmental)	1414	1997 2010	4140127 4140421
2	Protean Automatic Proportional Counter	WPC 4550		2910 1111
1	Perkin Elmer Liquid Scintillation Counter – Wallac Guardian (bioassay)	1414	1998	4140299
1	Perkin Elmer Liquid Scintillation Counter – Wallac Guardian (environmental)	1415	2010	4150033
2	Perkin Elmer Quantulus	1220	1998 2009	2200082 DG06095168
2	Ortec – Alpha Spectrometers	alpha ensemble-8	2010	10235232 10230971
7	Ortec – Alpha Spectrometers	octete-pc	2010	177, 182, 217, 266, 264, 144, 176
1	Perkin Elmer Liquid Scintillation Counter – Rackbeta	1219	2010	206147
1	Perkin Elmer ICPMS	ELAN 9000	2010	AJ13271005
1	Broad-Energy Germanium Detector(Carbon Comp. Window)	BE3825	2006	3068173
1	High Purity Germanium Coaxial Detector	GEM90210-P	1990	30-TP30546-A
1	High Purity Germanium Coaxial Detector	GEM-35190	2004	CV-P122204CA
1	High Purity Germanium Coaxial Detector	GEM35	2007	CV-PO42407CA
1	High Purity Germanium Coaxial Detector	GEM35P4-83	2008	CV-TP011608CA
1	High Purity Germanium Well Detector	GCW3523	1994	3941466
1	Low Energy Germanium Detector (Beryllium Window)	GL1015	1988	488926
1	Low Energy Germanium Detector (Beryllium Window)	GL1010S	1990	10902649
1	Low Energy Germanium Detector (Beryllium Window)	GL2820R	1995	1954119

1	Low Energy Germanium Detector (Beryllium Window)	GL2820R	1998	3984452
1	Low Energy Germanium Detector (Beryllium Window)	GL2020R	2007	9078304
1	Low Energy Germanium Detector (Carbon Comp. Window)	GL2020-S	1992	12922782
1	N-Type High Purity Germanium Coaxial Detector	GMX 45225-P-S	1990	37-TN11260A
1	N-Type High Purity Germanium Coaxial Detector	GMX30200-P	1990	30-TN10348
1	N-Type High Purity Germanium Coaxial Detector	NIG3019	1991	PGT2461
1	P-Type High Purity Germanium Coaxial Detector (Bioassay)	IGC3919	1993	2605
1	Reverse-Electrode Coaxial Germanium Detector (Beryllium Window)	GR3019	1986	9861606
1	Reverse-Electrode Coaxial Germanium Detector (Beryllium Window)	GR2020	1991	1912509
1	Reverse-Electrode Coaxial Germanium Detector (Carbon Comp. Window)	GR3520	1993	8932581
1	Reverse Electrode Coaxial Germanium Detector	GR3021	1992	3922553
1	Reverse Electrode Coaxial Germanium Detector (Beryllium Window)	GR4019	1996	1966073
2	Standard Electrode Coaxial Germanium Detector	GC3519	1991	9912854, 11912876
2	Standard Electrode Coaxial Germanium Detector	GC3520	1992 2000	12922955 2007152
4	Standard Electrode Coaxial Germanium Detector	GC2018	1992	9923035 9923043 10923049 10923050

1	Standard Electrode Coaxial Germanium Detector	GC3018	1993	5933088
1	Standard Electrode Coaxial Germanium Detector	GC3519	1994	1943234
1	Standard Electrode Coaxial Germanium Detector	GC8021	1994	8943324
1	Standard Electrode Coaxial Germanium Detector (Bioassay)	GC3519	1994	1943199
1	Standard Electrode Coaxial Germanium Detector	GC3519	1992 2005	3922907 7059000
8	Standard Electrode Coaxial Germanium Detector	GC4019	1995 2001 2006 2007	6953489 6953483 6953542 10017452 10017444 9069163 9069175 10079344
3	Standard Electrode Coaxial Germanium Detector	GC4020	2005 2006	10059017 10059015 4069118
4	Standard Electrode Coaxial Germanium Detector	GC4520	2009	4099544 4099570 10099624 11099639
1	N-Type High Purity Germanium Coaxial Detector	GMX35195-P-S	1991	34-TN-20891A
8	Ludlum Alpha Scintillation Detector	Ludlum-182	2007	PR036493 PR140731 PR101846 PR104617 PR078964 PR125015 PR351370 PR285111

2	KPA Phosphorescence Analyzer (Bioassay)	KPA-11A		91-45050014 05-45050162
1	Sartorius Balance	A200S		38080204
1	Sartorius Balance	CP2201		18150253
2	Sartorius Balance	CP323S		18550299 15750050
1	Sartorius Balance	CP 2202S		17955156
1	Sartorius Balance	HD 2000 D		39020004
2	Sartorius Balance	I 12000 S		40109033 39039003
1	Sartorius Balance	L2200S		38110007
1	Sartorius Balance	BP3100S		51204863
1	Sartorius Balance	U5000D		36080009
1	Sartorius Balance	R 300S		38110047
1	Sartoris Balance	LC6200S		30503875
1	Sartoris Balance	LC3201D		60108592
1	Sartoris Balance	TE313S		16107662
1	Sartoris Balance	ENTRIS5201		34104035
3	Sartoris Entirs Balance	ENTRIS5201-1S		33003774 33003775 33005595
1	Sartoris Entris Balance	ENTRIS224-15		33604148
1	Sartoris Entris Balance	ENTRIS52202-1S		33010896

1	Mettler Analytical Balance	AE160		C31514
1	Mettler Analytical Balance	AE163		F33394
2	Mettler Analytical Balance	AE200		F30560 1113021018
1	Mettler Analytical Balance	AE240		L28658
1	Mettler Analytical Balance	AE50		1113092273
1	Mettler Analytical Balance	PM16-N		N39169
1	Mettler Analytical Balance	PM 4600		J93763
1	OHAUS Toploader Balance	RD6RM		2525244

HIGH RAD ALIQUOT ROOM

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Adventurer Pro	AV2102	Oct-14	B440101411

LABORATORY INFORMATION MANAGEMENT SYSTEMS

#	Equipment	Model #	Purchase Date	ID/Serial #
1	DELL Poweredge 860 (vmhost01) 2 X 1.86Ghz 3G ram	860	2007	FDBKLC1
1	DELL Poweredge 2950 (mailsvr01) 4 X 3.0Ghz 2GB ram	2950	2007	DG2CNB1
1	Windows NT Server, NT4, 2 CPU 256 MB RAM 10 GB Disk (rad_server), 100 Mbps Eth card,	N/A	Aug-98	PC Server Class

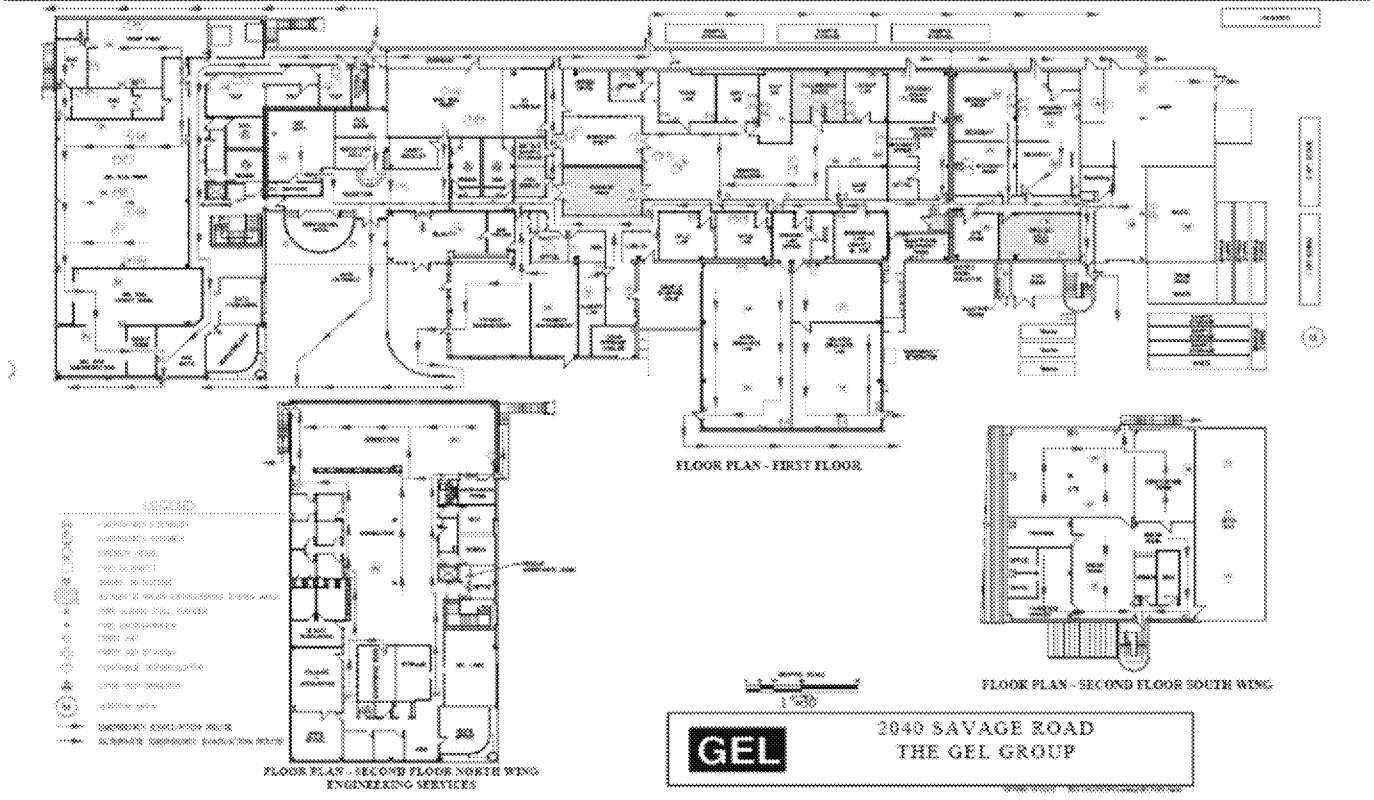
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (hpclp1) 50GB Disk (mirrored and RAID%), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (kilroy) 50GB Disk (mirrored and RAID5), Raid tower, 100 Mbps Eth card, Target Software	N/A	Nov-97	A3480A
1	HP9000 Dclass, HP-UX 10.20, 2 cpu, 256 MB RAM, (prdsvr07) 50GB Disk (mirrored and RAID5), Raid tower, Target Software	N/A	Nov-97	A3480A
1	Dell Poweredge sc420 (linuxsvr02) 2X3.6GHz processors. 1GB ram	SC420	2004	H4Q9G61
1	Rave - Ultra AX-MP (prodsvvr04) 2 CPU's, 1024 MB RAM, 60 GB Disk (mirrored)	E250	Mar-00	302971
1	Sun V440 (prodsvr03) 4X1.593Ghz 8GB ram	V440	2006	0515AD1489
1	Sun V890 (prodsvr01) 8X1.5Ghz) 32GB ram (mirrored and raid5)	V890	2007	0529AM019F
1	Sun V890(standbysvr01) 4X1.35Ghz 16GB (mirrored and rad5)	V890	2008	0526AM02F
1	Aberdeen Sterling S38i (linuxsvr04) 4x3.1 GHz, 1.5GB RAM, 168 GB (RAID5)	Sterling S38i	2006	F14102A3420394
1	Aberdeen Sterling S38i (linuxsvr05) 4x1.8 GHz, 1.5GB RAM, 168 GB (RAID5)	Sterling S38i	2006	F14102A3470669
1	Apple- Xserve G% 2x2.5 GHzCPU's, 1.0 GB RAM, 3x400 GB Disks (mirrored)	Xserve G5	2006	QP5020HKRTS
1	Apple-Xserv RAID 14x400 GB Disks (RAID5)	Xserve RAID	2006	QP503007R56
1	HP-Prolient DL360 (vmhost02) 2-QuadCoreX2.83GHz 16GB	DL360	2009	MXQ904A2SR

1	HP-Prolient DL360 (vmhost03) 2-QuadCoreX2.83GHz 16GB	DL361	2009	MXQ903A3RA
1	HP-Prolient DL360 (vmhost04) 2-QuadCoreX2.83GHz 16GB	DL362	2009	MXQ903A3KSS
1	HP2012i (san01) DC Modular Smart Array	2012i	2009	3CL904C108
1	EMC Storage Array Network (SAN)	VNX5200	Jan-2015	APM00145036951

UNIVERSAL POWER SUPPLY

#	Equipment	Model #	Purchase Date	ID/Serial #
1	Power ware 9315	9315	Jul-05	ES443ZXX57

APPENDIX H: FACILITIES WITH EVACUATION ROUTES



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APPENDIX I: STANDARD OPERATING PROCEDURES AND ANALYTICAL METHODS

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-ADM-E-001	Preparation, Authorization, Advance Change, Revision, Release, and Retirement of Standard Operating Procedures	N/A
GL-AP-E-001	Invoicing Analytical Lab Numbers	N/A
GL-CO-E-001	Revising GEL Laboratories Catalog of Analytical Services	N/A
GL-CO-E-002	Delegated Authority to Commit the Company	N/A
GL-CO-E-003	Request for Proposal (RFP) and Contract Review	N/A
GL-CS-E-002	Internal Review of Contractually Required Quality Criteria for Client Package Delivery	N/A
GL-CS-E-005	Electronic Data Deliverables	N/A
GL-CS-E-006	Subcontracting Analytical Services	N/A
GL-CS-E-008	Prelogin, Login, and Login Review	N/A
GL-CS-M-001	Project Management AlphaLIMS Manual	N/A
GL-DC-E-001	Document Control	N/A
GL-FC-E-001	Facility Security	N/A
GL-FC-E-002	Testing Emergency Eyewash and Shower Equipment	N/A
GL-FC-E-003	Fume Hood Face Velocity Performance Checks	N/A
GL-FC-E-004	Inspection of Fire Extinguishers	N/A
GL-GC-E-001	Total Dissolved Solids	EPA 160.1, 2540C
GL-GC-E-004	General Chemistry Standards, Definitions, and Preparation	N/A
GL-GC-E-007	Total Organic Halogen (TOX) and Adsorbable Organic Halides on Liquid Samples Using the Mitsubishi TOX-10 Analyzer	1650C, 9020B
GL-GC-E-008	pH	EPA 150.1, 9040, 9041A, 9045 4500-H^+ -00
GL-GC-E-009	Conductivity and Salinity	EPA 120.1, 9050A, SM 2510B-97, SM 2520B-10
GL-GC-E-010	Paint Filter Test	EPA 9095
GL-GC-E-011	Total Solids	EPA 160.3, 2540B, 2540G-2011
GL-GC-E-012	Total Suspended Solids	EPA 160.2, 2540D
GL-GC-E-028	Carbonaceous Biochemical Oxygen Demand (CBOD)	EPA 405.1, 5210B-01
GL-GC-E-029	Corrosivity Toward Steel	1110(M), 1110A(M)
GL-GC-E-032	Carbon Dioxide (Total and Free) by Calculation	4500-CO_2 D
GL-GC-E-033	Alkalinity: Total, Bicarbonate, Carbonate, Hydroxide, and Phenolphthalein	EPA 310.1(M), 2320B-97
GL-GC-E-035	Volatile Suspended Solids	EPA 160.2, 160.4, 2540E
GL-GC-E-036	Color by Visual Comparison	EPA 110.2, 2120B
GL-GC-E-037	Turbidity	180.1, 2130-B

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-GC-E-040	Pretreatment of Cyanide Amenable to Chlorination	EPA 335.1, 9010, 9012 4500-CN^- G-99
GL-GC-E-044	Colorimetric Determination of Hexavalent Chromium	7196A, 3500-Cr D, 3060A
GL-GC-E-045	Biochemical Oxygen Demand (BOD)	EPA 405.1, 5210B
GL-GC-E-047	Methylene Blue Active Substance	EPA 425.1, 5540C
GL-GC-E-048	Heating Value Determination by Bomb Calorimeter	ASTM D 240, 4809-13, E 711(M)
GL-GC-E-052	Sulfide (Methylene Blue Method)	EPA 376.2(M), HACH 8131, 4500 S^{2-} D
GL-GC-E-056	Sulfite	4500-SO_3^{2-} B-2000, EPA 377.1
GL-GC-E-057	Volatile Solids and % Ash Procedure for Water Samples	EPA 160.4, 2540E
GL-GC-E-058	Volatile Solids and % Ash Procedure for Solid and Semisolid Samples	2540G
GL-GC-E-059	Dissolved Oxygen Analysis by Membrane Electrode Method	4500-O^- G, EPA 360.1
GL-GC-E-061	Chemical Oxygen Demand (COD) Digestion Reactor Method	EPA 410.4, 5220-D, HACH 8000
GL-GC-E-062	Total Carbon and Total Organic Carbon Analysis Using the Dohrmann DC-190 Boat Sampler	9060 (M), 5310-B
GL-GC-E-064	Density	ASTM D5057
GL-GC-E-065	Specific Gravity	ASTM D5057
GL-GC-E-066	Flashpoint by Setaflash	1020 ASTM D 3278-78
GL-GC-E-067	Cyanide Sample Distillation	9012, 9010 335.3, 335.4, 335.2-M, 4500-CN^- C
GL-GC-E-068	Viscosity	Manufacturer's Method
GL-GC-E-069	Reactive Cyanide and Sulfide	SW-846 Chap 7.3.3, Chap 7.3.4
GL-GC-E-071	Total Phosphorous and Total Kjeldahl Nitrogen Sample Preparation	EPA 365.4, 351.2, 4500N_{org}-D-2011
GL-GC-E-072	Ammonia-Nitrogen Sample Preparation	EPA 350.1, 4500-NH_3^- B
GL-GC-E-073	Free Cyanide Analysis by Microdiffusion	ASTM D 4282
GL-GC-E-074	Extractable Organic Halides (EOX) Using the Dohrmann DX-2000 Analyzer	SW-846 9023
GL-GC-E-076	Total Residue Chlorine	4500-Cl G
GL-GC-E-077	Cyanide Weak Acid Dissociable Sample Preparation and Analysis	EPA 335.4, 4500-CN^-I
GL-GC-E-079	Bomb Preparation Method for Solid Waste	5050
GL-GC-E-082	Acid-Soluble Sulfides	9030, 9034
GL-GC-E-086	Ion Chromatography (IC)	EPA 300.0, 9056
GL-GC-E-087	Percent Water by Karl Fischer Titration	ASTM E203-08
GL-GC-E-090	Acidity	2310B

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-GC-E-091	Wavelength Calibration Verification of Thermospectronic Spectrophotometers	N/A
GL-GC-E-092	General Chemistry Data Review and Packaging	N/A
GL-GC-E-093	Total, Total Inorganic and Total Organic Carbon (TOC) using the OI Analytical Model 1010 TOC Analyzer	EPA 415.1, 9060, 5310B-2011
GL-GC-E-094	N-Hexane Extractable Material (HEM; Oil and Grease) and Silica GEL Treated N-Hexane Extractable Material (SGT-HEM Non-Polar Material) in Aqueous Matrices	1664
GL-GC-E-095	Cyanide Analysis by Lachat QuikChem 8000 FIA	CLP 335.2-M, 335.3. 335.4, 9010, 9012, 4500-CN^- E
GL-GC-E-096	Perchlorate by Ion Chromatography (IC)	EPA 314.0
GL-GC-E-100	Total Hardness by Titration	SM 2340C-97
GL-GC-E-102	Total Recoverable Phenol by the Lachat QuikChem FIA+ 8000 Series	EPA 420.4, 9066
GL-GC-E-103	Total Phosphorus by the Lachat Quickchem FIA+ 8000 Series Instrument	EPA 365.4, 4500 P H
GL-GC-E-104	Total Kjeldahl Nitrogen (TKN) Using the Lachat QuikChem FIA+ 8000 Series Instrument	EPA 351.2, 4500 N_{org} D
GL-GC-E-106	Ammonia Determination by the Lachat Quickchem FIA + 8000 Series	EPA 350.1 Rev 2, 4500-NH_3 H
GL-GC-E-107	Inorganic Calculations	N/A
GL-GC-E-123	Column Settling	EM 1110-02-5027
GL-GC-E-127	Modified Elutriate Test	N/A
GL-GC-E-128	Nitrate/Nitrite (NO_3+NO_2) Analysis Using The Lachat QuickChem FIA + 8000 Series Instrument	EPA 353.2, 4500-NO_3^-
GL-GC-E-129	Air Filter Particulates	N/A
GL-GC-E-130	Percent Ash Determined at 775 C Procedure for Solid and Semisolid Samples	ASTM D 482-03 (M)
GL-GC-E-132	Hexavalent Chromium by Lachat	SM 3500-Cr B-2011
GL-HR-E-002	Employee Training	N/A
GL-IT-E-001	Information Technology Program for Good Laboratory and Good Manufacturing Practices	N/A
GL-IT-E-002	Computer Systems Team Roles and Responsibilities	N/A
GL-IT-E-003	Requirements, Design, Operation, Validation and Removal of Hardware and Software Systems Used by the GEL Group, Inc.	N/A
GL-IT-E-004	Change Control Requirements for Hardware and Software	N/A
GL-IT-E-005	Requirements, Design, Operation, Validation and Removal of Applications Used by The GEL Group, Inc.	N/A
GL-IT-E-006	Change Control Requirements for Applications	N/A
GL-IT-E-007	User Roles and Responsibilities for Personnel Using Computer Services	N/A

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-IT-E-009	Archive and Retrieval of Systems Information	N/A
GL-IT-E-010	Backup of Computer Controlled Instrumentation	N/A
GL-IT-E-011	System Security and Virus Protection	N/A
GL-IT-E-012	Application Tools used by Computer Services Personnel	N/A
GL-IT-E-013	GEL Electronic Processes and LIMS Audit System	N/A
GL-IT-E-014	Disaster Recovery	N/A
GL-IT-E-015	Operation of LIMS Database Primary and Failover Servers	N/A
GL-LB-E-001	The Determination of Method Detection Limits	N/A
GL-LB-E-002	Balances	N/A
GL-LB-E-003	Glassware Preparation	N/A
GL-LB-E-004	Temperature Monitoring and Documentation Requirements for Refrigerators, Ovens, Incubators, and Other Similar Devices	N/A
GL-LB-E-005	Data Review and Validation	N/A
GL-LB-E-006	Toxicity Characteristic Leaching Procedure Preparation	SW-846 1311
GL-LB-E-007	Laboratory Standards Documentation	N/A
GL-LB-E-008	Basic Requirements for the Use and Maintenance of Laboratory Notebooks, Logbooks, Forms and Other Recordkeeping Devices	N/A
GL-LB-E-009	Run Logs	N/A
GL-LB-E-010	Maintenance and Use of Air Displacement Pipets	N/A
GL-LB-E-012	Verifying the Maintenance of Sample Integrity	N/A
GL-LB-E-013	CLP-Like/DOE Data Package Assembly and Revision	N/A
GL-LB-E-016	The Collection and Monitoring of the DI Water Systems	N/A
GL-LB-E-017	Procedure and Policy for Manual Integration	N/A
GL-LB-E-018	Instrument Clock Verification	N/A
GL-LB-E-020	Tuning of High Intensity Ultrasonic Processor	N/A
GL-LB-E-022	Generation of Swipe Data	N/A
GL-LB-E-023	Waste Extraction Test (WET)	N/A
GL-LB-E-024	Synthetic Precipitation Leaching Preparation	EPA 1312
GL-LB-E-026	Container Suitability Testing	N/A
GL-LB-E-027	Bioassay Kit Delivery and Retrieval	N/A
GL-LB-E-029	Laboratory Sub-Sampling	N/A
GL-LB-E-030	Silica Gel and Air Filter Removal and Replacement	N/A
GL-LB-E-031	Sample Compositing	N/A
GL-LB-E-032	The Distribution of High Risk and Limited Volume Samples	N/A
GL-LB-E-033	Proper Peak Identification for Organics	N/A
GL-LB-E-034	Laboratory Filtration Samples	N/A
GL-LB-G-001	Laboratory Waste Management Plan	N/A

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-LB-N-001	Safety, Health and Chemical Hygiene Plan	N/A
GL-LB-S-001	Disaster Preparedness and Recovery Plan	N/A
GL-MA-E-006	Acid Digestion of Total Recoverable or Dissolved Metals in Surface and Groundwater Samples for Analysis by ICP or ICP-MS	3005A
GL-MA-E-008	Acid Digestion of Total Metals in Aqueous Samples and Extracts for Analysis by ICP and ICP-MS	3010A
GL-MA-E-009	Acid Digestion of Sediments, Sludges, and Soils	3050B, 6010, 6020
GL-MA-E-010	Mercury Analysis Using the Perkin Elmer Automated Mercury Analyzer	245.1, 245.2, 7470, 7471
GL-MA-E-013	Determination of Metals by ICP	EPA 200.7, 6010
GL-MA-E-014	Determination of Metals by ICP-MS	6020, EPA 200.8,
GL-MA-E-016	Sample Preparation for Total Recoverable Elements by EPA Method 200.2	EPA 200.2
GL-MA-E-017	Metals Data Validation	N/A
GL-MA-E-018	Mercury Analysis using the PS Analytical Millennium Automated Mercury Analyzer	EPA 1631 Rev E
GL-MA-E-020	Acid Digestion of Personal Cassette Filters for Analysis by ICP	NIOSH 7303
GL-OA-E-001	Establishing Retention Time Windows for GC and HPLC Analysis	SW-846 8000
GL-OA-E-003	Non-Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	8000, 8015, 3541, 3580
GL-OA-E-004	Volatile Total Petroleum Hydrocarbons by Flame Ionization Detector	5030, 5035, 8000, 8015
GL-OA-E-009	Analysis of Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry	8270, EPA 625
GL-OA-E-010	Extraction of Semivolatile and Nonvolatile Organic Compounds from Soil, Sludge, and Other Miscellaneous Solid Samples	3500, 3550, 8270, 8081, 8082, 8015, 8310
GL-OA-E-011	Analysis of Chlorophenoxy Acid Herbicides by ECD	8000, 8151A
GL-OA-E-013	Extraction of Semivolatile and Nonvolatile Organic Compounds from Groundwater, Wastewater, and Other Aqueous Samples	3510, 8270, 8081, 8082, 8015 8310, 608, 625, AK102, 103,
GL-OA-E-015	The Extraction of Herbicides from Groundwater, Wastewater, and Other Aqueous Samples	8151
GL-OA-E-020	Percent Moisture	ASTM D2216-05
GL-OA-E-022	Volatile Organic Compounds by Gas Chromatograph/Mass Spectrometer Applicable to EPA Method 524.2	EPA 524.2
GL-OA-E-026	Volatile Organic Compounds (VOC) by Gas Chromatograph/Mass Spectrometer	EPA 624
GL-OA-E-027	The Extraction of Herbicides from Soil and Sludge Samples	8151
GL-OA-E-030	Polynuclear Aromatic Hydrocarbons	8310

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-OA-E-033	Nitroaromatics and Nitramines by High Performance Liquid Chromatography (HPLC)	8000, 8330A,
GL-OA-E-036	Florisil Cleanup of Organochlorine Pesticide Solvent Extracts	3510, 3620, 3550,8081,
GL-OA-E-037	Sulfuric Acid/Permanganate Cleanup of PCB Solvent Extract	3550C, 3665A, 8082,
GL-OA-E-038	Volatile Organic Compounds (VOC) by Gas Chromatograph/Mass Spectrometer	8260, 5030, 5035, 8000, 3585, SM 6200
GL-OA-E-039	Closed-System Purge-and-Trap Collection and Extraction Volatile Organics in Soil and Waste Samples	EPA 5035
GL-OA-E-040	Polychlorinated Biphenyls	8000, 8082, 608
GL-OA-E-041	Organochlorine Pesticides and Chlorinated Hydrocarbons	8000, 8081, 608
GL-OA-E-045	Sulfur Clean-up	3660B
GL-OA-E-046	Common Industrial Solvents, Glycols, and Various Organic Compounds by Flame Ionization Detector	8000, 8015
GL-OA-E-047	Gel Permeation Cleanup of Solvent Extracts	3640A, 3510C, 3550C, 8270, 8081, 8082
GL-OA-E-049	Silica Gel Cleanup Using Solid Phase Silica Gel Extraction Cartridges	3550C, 3510C, 3630C, 3541
GL-OA-E-050	The Extraction of Semi-Volatile and Nonvolatile Organic Compounds from Oil	3580, 8015, 8081, 8082, 8081, 8270
GL-OA-E-055	The Determination of Diesel Range and Residual Range Organics	AK102. AK 103, 3510C, 3550B
GL-OA-E-056	Definitive Low Level Analysis of Nitroaromatic Explosives Utilizing Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS) by SW-846 Method 8321 Modified (8321M)	8321A(M), 8000, 8330(M), , 8330B(M)
GL-OA-E-058	Volatile Storage Blanks	N/A
GL-OA-E-059	Analysis of 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP) in Water by GC/ECD Using Methods 504.1 or 8011	EPA 504.1, 8011
GL-OA-E-061	Haloacetic Acids in Water	EPA 552.2
GL-OA-E-063	Massachusetts Method for the Determination fo Extractable Petroleum Hydrocarbons	Massachusetts EPH
GL-OA-E-064	Dissolved Gases in Water by Flame Ionization Detector (FID)	RSK-175
GL-OA-E-065	Reagent/Solvent/Standards Screening for Organic Prep	N/A
GL-OA-E-066	Automated Soxhlet Extraction	EPA 3541, 3600
GL-OA-E-067	Definitive Low Level Perchlorate Analysis Utilizing Liquid Chromatography/Mass Spectrometry/Mass Spectrometry (LC/MS/MS) by EPA Method 6850 Modified (6850M)	6850(M),
GL-OA-E-068	The Processing, Extraction, and Analysis of Nitroaromatics, Nitroamines, and Nitrate Esters by SW-846 8330B	8330B, 3535
GL-OA-E-069	Continuous Liquid-Liquid Extraction	3520C
GL-OA-E-070	Solid-Phase Extraction	EPA 3535

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-OA-E-071	The Pre-Extraction Processing of Soil Samples Collected Using Multi-Incremental Sampling (MIS) Techniques	EPA 8330B
GL-OA-E-073	Analysis of 1,4-Dioxane in Drinking Water by Solid Phase Extraction (SPE) and Gas Chromatography/Mass Spectrometry	EPA 522
GL-OA-E-074	Massachusetts Volatile Petroleum Hydrocarbons by Photoionization and Flame Ionization Detectors	N/A
GL-OA-E-075	Washington Method for the Determination of Extractable Hydrocarbons	WA EPH
GL-QS-B-001	Quality Assurance Plan	N/A
GL-QS-B-002	DoD ELAP Quality Assurance Plan	N/A
GL-QS-E-001	Conduct of Quality Audits	N/A
GL-QS-E-002	Conducting Corrective/Preventive Action and Identifying Opportunities for Improvement	N/A
GL-QS-E-003	Training and Qualifying Quality Assurance Audit Personnel	N/A
GL-QS-E-004	AlphaLIMS Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items	N/A
GL-QS-E-005	Review of Monitoring Device Logs	N/A
GL-QS-E-007	Thermometer Verification	N/A
GL-QS-E-008	Quality Records Management and Disposition	N/A
GL-QS-E-011	Method Validation and Initial and Continuing Demonstrations of Capability	N/A
GL-QS-E-012	NCR Database Operation	N/A
GL-QS-E-013	Handling of Proficiency Evaluation Samples	N/A
GL-QS-E-014	Quality Assurance Measurement Calculations and Processes	N/A
GL-QS-E-015	Use of Logos and Describing Accredited Status	N/A
GL-QS-E-016	Identification and Implementation of New and Revised Methods	N/A
GL-QS-E-017	Maintaining Technical Training Records	N/A
GL-QS-E-018	Communication of Substantial Nonconforming Safety Related Services	N/A
GL-QS-E-019	Trending of Performance Evaluation Data	N/A
GL-RAD-A-001	The Determination of Gross Alpha And Gross Non-Volatile Beta in Water	900.0, 9310
GL-RAD-A-001B	The Determination of Gross Alpha And Gross Non-Volatile Beta in Soil, Filters, Solid Matrices and Direct Count Air Filters	900.0(M), 9310
GL-RAD-A-001C	The Determination of Gross Alpha in Water by Co-precipitation	520/5-84-006 Method 00-02
GI-RAD-A-001D	The Determination of Gross Alpha Gross Non-Volatile Beta in Drinking Water	600/4-80-032 Method 900.0

Standard Operating Procedures and Analytical Methods

SOP #	SOP Title	Methods
GL-RAD-A-002	The Determination of Tritium	600/4-80-032, 906.0(M)
GL-RAD-A-003	The Determination of Carbon-14 in Water, Soil, Vegetation and Other Solid Matrices	N/A
GL-RAD-A-004	The Determination of Strontium 89/90 in Water, Soil, Milk, Filters, Vegetation and Tissues	905.0(M), DOE RP501 Rev1(M), HASL 300(M)
GL-RAD-A-005	The Determination of Technitium-99 Using TEVA Resin	HASL 300(M) TC-02-RC, DOE RP550(M), ASTM C 1387-03(M), ASTM 1476-00(M)
GL-RAD-A-006	The Determination of Radiometric Iodine	901.1(M), HASL 300(M) I-01
GL-RAD-A-007	The Determination of Radon-222 in Water	SM 7500 Rn-B
GL-RAD-A-008	The Determination of Radium-226	903.1(M), HASL 300(M) Ra-04-RC
GL-RAD-A-009	The Determination of Radium-228 in Water and Solids	904.0(M)
GL-RAD-A-010	Total Alpha Radium Isotopes in Soil and Water	900.1(M)
GL-RAD-A-011	The Isotopic Determination of Americium, Curium, Plutonium, and Uranium	DOE RP800 1997(M), HASL-300 U-02-RC(M), HASL-300 Am-05-RC(M) HASL-300 Pu-11-RC(M)
GL-RAD-A-013	The Determination of Gamma Isotopes	901.1 (M), HASL-300 (M) Sec. 4.5.2.3, HASL-300 Ga-01-R
GL-RAD-A-015	Digestion for Soil	N/A
GL-RAD-A-016	The Determination of Radiometric Polonium	EPA 600/4-80-032
GL-RAD-A-017	The Determination of Iodine-131 in Drinking Water	902.0, 7500 I^- B
GL-RAD-A-018	The Determination of Lead-210 in Liquid and Solid Matrices	N/A
GL-RAD-A-019	Determination of Phosphorus-32 in Soil and Water	N/A
GL-RAD-A-020	The Determination of Promethium-147 in Soil and Water	N/A
GL-RAD-A-021	Soil Sample Preparation for the Determination of Radionuclides	N/A
GL-RAD-A-021B	Soil Sample Ashing for the Determination of Radionuclides	N/A
GL-RAD-A-022	The Determination of Ni-59 and Ni-63	N/A
GL-RAD-A-023	Total Uranium in Environmental Samples by Kinetic Phosphorescence	ASTM D 5174-91, 5174-97, 5174-02
GL-RAD-A-026	The Preparation of Special Matrices for the Determination of Radionuclides	N/A
GL-RAD-A-028	Radium-226 in Drinking Water by EPA Method 903.1	EPA 903.1
GL-RAD-A-029	The Determination of Strontium-89/90 in Drinking Water by EPA Method 905.0	EPA 905.0
GL-RAD-A-030	Determination of Radium-228 in Drinking Water	904.0, 9320
GL-RAD-A-031	The Determination of Selenium	N/A
GL-RAD-A-032	The Isotopic Determination of Neptunium/Thorium	N/A
GL-RAD-A-033	Determination of Chlorine-36 in Solid and Liquid Samples	N/A

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SOP #	SOP Title	Methods
GL-RAD-A-035	The Isotopic Determination of Plutonium-241	HASL-300 Pu-11-RC(M)
GL-RAD-A-036	The Isotopic Determination of Americium, Curium, and Plutonium in Large Soil Samples	DOE RP800(M) HASL-300 Am-05-RC(M) HASL-300 Pu-11-RC(M) HASL-300 Pu-12-RC(M)
GL-RAD-A-037	Radium-226 and Radium-228 in Drinking Water by Sulfate Precipitation and Gamma-Ray Spectrometry	N/A
GL-RAD-A-038	The Isotopic Determination of Thorium	DOE RP800(M), HASL-300(M) Pu-02-RC, Pu-03-RC
GL-RAD-A-040	The Determination of Fe-55 in Liquid and Solid Matrices by Liquid Scintillation Counter	N/A
GL-RAD-A-041	The Determination of Total Activity in Solids and Liquids	N/A
GL-RAD-A-044	Total Alpha Radium Isotopes In Drinking Water	903.0, 9315, HASL 300(M)
GL-RAD-A-046	The Determination of Radium-224 and Radium-226 by Alpha Spectroscopy	N/A
GL-RAD-A-047	48 Hour Rapid Gross Alpha Test	ECLS-R-G-A, EPA 600/4-80-032, 900.0(M)
GL-RAD-A-048	The Determination of Calcium-45 in Soils and Waters	N/A
GL-RAD-A-049	The Determination of Sulfur-35	NAS-NS-3054
GL-RAD-A-050	The Determination of Tritium in Drinking Water Samples	600/4-80-032, 906.0
GL-RAD-A-051	The Rapid Determination of Strontium 89/90 by Cerenkov Counting	N/A
GL-RAD-A-052	The Determination of Organically Bound Tritium	600\4-80-032, 906.0
GL-RAD-A-053	Isotopic Determination of Plutonium in Large Water Resin Samples	HASL 300 Pu-11-RC
GL-RAD-A-054	The Determination of Strontium-90 in Brine	N/A
GL-RAD-A-055	The Preparation of Environmental Samples for Isotopic Uranium Analysis Via ICP-MS	N/A
GL-RAD-A-056	The Determination of Gross Alpha and Beta by Liquid Scintillation Counter	N/A
GL-RAD-A-057	Rapid Determination of Radium-226 by Alpha Spec	N/A
GL-RAD-A-058	The Rapid Determination of Strontium 89/90 by Gas Flow Proportional Counting	N/A
GL-RAD-A-059	The Determination of Technetium-99 Using Analytical Grade 1X8 Resin	N/A
GL-RAD-A-060	The Preparation of Vegetation and Filter Samples Via Organic Destruction and Strong Acid Leach for Radiochemistry Metals Analysis	N/A
GL-RAD-A-062	The Determination of Tritium by Combustion	N/A
GL-RAD-A-063	The Determination of Radium-228	N/A

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SOP #	SOP Title	Methods
GL-RAD-A-065	The Determination of Carbon-14 in Atmospheric Screening Cartridges	N/A
GL-RAD-A-066	The Determination of Radiometric Polonium Using DGA Cartridges	N/A
GL-RAD-A-067	The Determination of Radiometric of Tritium and Carbon 14 in Combustible Materials Using Pyrolysis	N/A
GL-RAD-B-001	The Sequential Determination of Isotopic Americium, Curium, Californium, Plutonium, Strontium and Uranium in Urine	N/A
GL-RAD-B-002	The Determination of Polonium-210 or Radium-226 in Bioassay Samples	N/A
GL-RAD-B-005	Management of Blank Populations	N/A
GL-RAD-B-008	The Determination of Gross Alpha Activity in Nasal Swipes	N/A
GL-RAD-B-009	Bioassay Countroom Alpha Spectroscopy Instrument Standardization and Performance	N/A
GL-RAD-B-010	The Determination of Thorium in Fecal Samples	N/A
GL-RAD-B-011	The Determination of Tritium in Urine	EPA 906
GL-RAD-B-012	The Ashing of Fecal, Bone, and Tissue Samples	N/A
GL-RAD-B-013	Sequential Determination of Americium, Plutonium, Strontium, Plutonium-241, and Uranium in Fecal, Bone, and Tissue Samples	N/A
GL-RAD-B-014	The Preparation of Synthetic Urine and Fecal Material	N/A
GL-RAD-B-016	The Determination of Technetium-99 in Urine	N/A
GL-RAD-B-017	The Determination of Neptunium in Urine	N/A
GL-RAD-B-018	Operation of the Chemchek Automatic KPA	N/A
GL-RAD-B-019	Total Uranium in Bioassay Samples by Kinetic Phosphorescence	ASTM D 5174-02, ASTM D 5174-97
GL-RAD-B-020	The Determination of Ni-59 and Ni-63 in Urine	N/A
GL-RAD-B-022	The Determination of Gross Alpha and Gross Non-volatile Beta in Urine	EPA 900.0, 9310, EERF 00-01, USGS R-1120-76
GL-RAD-B-023	The Determination of Carbon-14 in Urine	EERF C-01(M)
GL-RAD-B-024	Managing Statistical Data in the Bioassay Laboratory	N/A
GL-RAD-B-025	The Combination and Preservation of Urine Samples	N/A
GL-RAD-B-026	Bioassay Data Review, Validation and Data Package Assembly	N/A
GL-RAD-B-027	Specific Gravity in Urine	ASTM D5057
GL-RAD-B-029	The Determination of Radiometric Iodine in Urine	N/A
GL-RAD-B-030	The Preparation and Determination of Gamma Isotopes in Urine and Fecal Samples	600/4-80-032
GL-RAD-B-031	Bioassay Quality Control Package Assembly	N/A
GL-RAD-B-032	Concentration of Tritium by Electrolysis	HASL H-02-RC, EML-95-110 Rev 2

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SOP #	SOP Title	Methods
GL-RAD-B-033	Bioassay Count Room Alpha Spectrometry Instrument Calibration	N/A
GL-RAD-B-034	The Determination of Metals by ICP-MS	N/A
GL-RAD-B-035	The Preparation of Urine Samples for Total Uranium Analysis by ICP-MS	N/A
GL-RAD-B-036	Initial Installation and Returning to Service of Repaired Instrumentation	N/A
GL-RAD-B-038	The Determination of Neptunium in Fecal Samples	N/A
GL-RAD-B-039	The Determination of Iron-55 in Urine	N/A
GL-RAD-B-040	The Determination of Radium-224 and Radium-226 by Alpha Spectroscopy in Bioassay Sample	N/A
GL-RAD-B-041	The Isotopic Determination of Thorium and Neptunium in Fecal Samples	N/A
GL-RAD-B-002	The Isotopic Determnation of Thorium and Neptunium in Fecal Samples	N/A
GL-RAD-D-002	Analytical Methods Validation for Radiochemistry	N/A
GL-RAD-D-003	Data Review, Validation, and Data Package Assembly	N/A
GL-RAD-D-005	REMP Quality Control Package Assembly	N/A
GL-RAD-D-006	Equations Used in Data Reduction for Environmental Radiochemistry	N/A
GL-RAD-I-001	Gamma Spectroscopy System Operation	N/A
GL-RAD-I-004	Beckman LS-6000/6500	N/A
GL-RAD-I-006	LB4100 Gross Alpha/Beta Counter Operating Instructions	N/A
GL-RAD-I-007	Ludlum Lucas Cell Counter	N/A
GL-RAD-I-008	VAX/VMS Quality Control Software Program	N/A
GL-RAD-I-009	Alpha Spectroscopy System	N/A
GL-RAD-I-010	Counting Room Instrumentation Maintenance	N/A
GL-RAD-I-012	Managing Statistical Data in the Radiochemistry Laboratory	N/A
GL-RAD-I-013	Column Preparation	N/A
GL-RAD-I-014	WALLAC Guardian Model 1414	N/A
GL-RAD-I-015	WPC 9550 Gross Alpha/Beta Counter: Operating Instructions	N/A
GL-RAD-I-016	Multi-Detector Counter: Operating Instructions	N/A
GL-RAD-I-017	Wallac 1220 Quantalus Liquid Scintillation Counter	N/A
GL-RAD-I-018	Operation of Wallac 1480 Gamma Wizard	N/A
GL-RAD-I-019	Management of Blank Populations	N/A
GL-RAD-M-001	Preparation and Verification of Radioactive Standards	N/A

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SOP #	SOP Title	Methods
GL-RAD-M-003	Restoring Data from Magnetic Tape for Bioassay and Alpha Spectroscopy	N/A
GL-RAD-S-000	Radiation Safety Plan for GEL Laboratories, LLC	N/A
GL-RAD-S-001	Radiological Surveys	N/A
GL-RAD-S-002	Radiation Related Emergencies	N/A
GL-RAD-S-003	Administration of the Radioactive Material License Inventory	N/A
GL-RAD-S-004	Radioactive Material Handling	N/A
GL-RAD-S-006	Radiation Worker Training	N/A
GL-RAD-S-007	Receiving Radioactive Packages	N/A
GL-RAD-S-009	Personnel Dosimetry	N/A
GL-RAD-S-010	The Handling of Biological Materials	N/A
GL-RAD-S-013	Air Sampling for Radioactivity	Guide 825
GL-RAD-S-014	Release of Laboratory Coats	N/A
GL-RAD-S-015	The Acceptance and Classification of Radioactive Material	N/A
GL-RAD-S-016	Radiation Work Permits	N/A
GL-RAD-S-018	Laboratory Analysis of High Activity (RAD 3) Samples	N/A
GL-RC-E-001	Receipt and Inspection of Material and Services	N/A
GL-RC-E-002	Material Requisition	N/A
GL-SR-E-001	Sample Receipt, Login, and Storage	N/A
GL-SR-E-002	Transportation and Shipping of Samples and Pre-Preserved Sample Containers	N/A
GL-SR-E-003	The Inspection, Cleaning and Screening of Sample Coolers	N/A
GL-SR-E-004	Control of Foreign Soils	N/A
GL-SR-E-005	Wipe Test	N/A
GL-SVR-D-001	Design Specifications for the Network Infrastructure	N/A
GL-SVR-D-002	Design Specifications for the Mail Server	N/A
GL-SVR-D-005	Design Specifications for Backupsvr01	N/A
GL-SVR-E-001	Network Infrastructure	N/A
GL-SVR-E-002	The Mail Server	N/A
GL-SVR-E-005	Backupsvr01	N/A
GL-SVR-R-001	System Requirements for Network Infrastructure	N/A
GL-SVR-R-002	System Requirements for The Mail Server	N/A
GL-SVR-R-005	System Requirements for Backupsvr01	N/A

APPENDIX J: SAMPLE STORAGE AND PRESERVATION REQUIREMENTS

STORAGE AND PRESERVATION

Parameter	Container [1]	Preservation	Holding Time[2]	Min. Volume[5]
INORGANICS				
Acidity	P,G	0 ≤ 6° C	14 days	25 mL / NA
Adsorbable Organic Halides (AOX)	G, amber	0 ≤ 6° C, HNO_3 to pH < 2	>3days and < 6 mos from collection	50 mL / 1 g
Alkalinity	P,G	0 ≤ 6° C	14 days	50 mL / NA
Biochemical Oxygen Demand (BOD) and Carbonaceous Oxygen Demand (CBOD)	**P,G**	**0 ≤ 6° C**	**48 hours**	**500 mL / NA**
Bromide	P,G	0 ≤ 6° C	28 days	10 mL / 4 g
Carbon Dioxide	**P,G**	**0 ≤ 6° C**	**Immediate**	**50 mL / NA**
Chemical Oxygen Demand (COD)	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	2 mL / NA
Chlorine by Bomb Calorimeter	P,G	0 ≤ 6° C	None	NA / 0.5 g
Chloride	P,G	0 ≤ 6° C	28 days	10 mL / 4 g
Color	**P,G**	**0 ≤ 6° C**	**48 hours**	**50 mL / NA**
Conductivity	P,G	0 ≤ 6° C	28 days	25 mL / NA
Corrosivity by pH	**P,G**	**None**	**Immediate**	**25 mL / 5 g**
Corrosivity to Steel	P,G	None	None	290 mL / NA
Cyanide amenable to chlorination	P,G	0 ≤ 6° C, NaOH to pH > 12, 0.6 g ascorbic acid [3]	14 days [4]	50 mL / NA
Cyanide, Reactive Releasable	G, amber	Zero headspace	7 days liquids, 28 days solids	10 mL / 10 g
Cyanide, total, available, free or Weak Acid Dissociable	P,G	0 ≤ 6° C, NaOH to pH > 12, 0.6 g ascorbic acid [3]	14 days [4]	50 mL / 1 g
Dissolved Oxygen	**G (bottle and top)**	**None, Zero headspace**	**Immediate**	**25 mL / NA**
Flashpoint	P,G	None	None	2 mL / 2 g Setaflash
Fluoride	P,G	0 ≤ 6° C	28 days	25 mL / 4 g
Fluorine by Bomb	P,G	0 ≤ 6° C	None	NA/ 0.5 g
Hardness (EDTA titration)	P,G	0 ≤ 6° C, HNO_3 to pH < 2	6 months	50 mL / NA
Hardness (calculation)	P,G	HNO_3 to pH < 2	6 months	50 mL / NA
Heating Value	P,G	0 ≤ 6° C	None	NA / 0.5 g

Hydrazine	G, teflon-lined septum	**HC1 to pH < 2**	**Immediate**	**50 mL / NA**
Nitrogen-Ammonia	P,G	0 ≤ 6° C, H_2SO_4 to pH< 2	28 days	100 mL / 5 g
Nitrate – Liquids	**P,G**	**0 ≤ 6° C**	**48 hours**	**10 mL**
Nitrate – Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Nitrite - Liquids	**P,G**	**0 ≤ 6° C**	**48 hours**	**10 mL**
Nitrite - Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Nitrate/Nitrite	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	4 mL / 4 g
Nitrogen - Total Kjeldahl and Organic	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	100 mL / 5 g
Oil and Grease	G	0 ≤ 6° C, HCl or H_2SO4 to pH < 2	28 days	1000 mL
Orthophosphate -Liquids	**P,G**	**Field filter immediately, 0 ≤ 6° C**	**48 hours**	**25 mL**
Orthophosphate – Solids	P,G	0 ≤ 6° C	28 days for extraction, 48 hrs from extraction to analysis	4 g
Paint Filter Liquids Test	Any	None	None	100 g
Percent (%) Moisture	P,G	0 ≤ 6° C	None	2 mL / 5 g
Perchlorate by Ion Chromatography	P,G	0 ≤ 6° C	28 days	10 mL / 1g
Total Phenols	G, amber	0 ≤6° C, H_2SO_4 to pH < 2	28 days	50 mL / 1 g
pH	**P,G**	**None if within 15 mins of collection,** 0 ≤ 6° C when shipped to lab	**Immediate**	**25 mL / 5 g**
Total Phosphorus	P,G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	20 mL / 1 g
Residual Chlorine	**P,G**	**0 ≤ 6° C**	**Immediate**	**25 mL / NA**
Residue, Total	P,G	0 ≤ 6° C	7 days	25 mL / NA
Residue, Filterable (TDS)	P,G	0 ≤ 6° C	7 days	25 mL / NA
Residue, NonFilterable (TSS)	P,G	0 ≤ 6° C	7 days	1000 mL
Residue, Volatile and Fixed (% Ash)	P,G	0 ≤ 6° C	7 days	25 mL / 1 g
Salinity	P,G	0 ≤ 6° C	28 days	25 mL / NA

Specific Gravity	P,G	0 ≤ 6° C	7 days	50 mL / NA
Sulfate	P,G	0 ≤ 6° C	28 days	10 mL / 4 g
Sulfide	P,G	0 ≤ 6° C, add ZnAc and NaOH to pH > 9	7 days	200 mL / 20 g
Sulfide, Reactive Releasable	G, amber	Zero headspace, 0 ≤ 6° C	7 days liquids, 28 days solids	10 mL / 10 g
Sulfide, Acid-Soluble	P,G	Zero Headspace, 0 ≤ 6° C Liquids: ZnAc and NaOH to pH > 9. Solids: Fill surface with 2N ZnAc	7 days liquids, 365 days solids	200 mL / 20 g
Sulfite	**P,G**	**EDTA[9]**	**Immediate**	**50 mL / NA**
Sulfur by Bomb	P,G	0 ≤ 6° C	None	NA / 0.5 g
Surfactants	**P,G**	**0 ≤ 6° C**	**48 hours**	**100 mL / NA**
Total Halogens	P,G	0 ≤ 6° C	None	1 mL / 1 g
Total Organic Carbon	G, amber	0 ≤ 6° C, HCl or H_2SO_4 to pH < 2	28 days	50 mL / 5 g
Total Organic Halides	G	0 ≤ 6° C, H_2SO_4 to pH < 2, Zero headspace	28 days	50 mL / 1 g
Total Petroleum Hydrocarbons	G	0 ≤ 6° C, H_2SO_4 to pH < 2	28 days	1000 mL / NA
TCLP (Toxicity Characteristic leaching Procedure) and Synthetic Precipitation Leaching Procedure (SPLP)	P,G depending on test	0 ≤6° C, depends on test	14 days, VOA 14 days, SVOA 28 days Mercury 180 days non-Hg metals	105 g or 130 g for full TCLP list
Turbidity	**P,G**	**0 ≤ 6° C**	**48 hours**	**50 mL / NA**
Viscosity	P,G	0 ≤ 6° C	None	7 mL
Metals – Liquids (except chromium VI and mercury)	P, (G as long as no B or Si is required)	HNO_3 to pH < 2	6 months	50 mL
Metals – Solids[8] (except chromium VI and mercury)	P, (G as long as no B or Si is required)	None	6 months	2 g
Chromium VI – Liquids	**P,G**	**0 ≤ 6° C**	**24 hours**	**25 mL**
Chromium VI - Liquids	P,G	0 ≤ 6° C, $(NH_4)_2SO_4$, pH = 9.3 to 9.7	28 days	25 mL

Chromium VI - Solids[8]	P,G	0 ≤ 6° C	30 days to digestion, 7 days from digestion to analysis	1 g
Mercury - Liquids	P,G	HNO_3 to pH < 2	28 days	50 mL
Mercury - Solids[8]	P,G	0 ≤ 6° C	28 days	2 g
Mercury – Low Level Liquids	P,G	HCl or BrCl	90 days when preserved w/in 48 hrs or oxidized w/in 28 days	50 mL

ORGANICS				
Method AK101-Solids[7]	Amber G	4 ± 2 °C, zero headspace, methanol	14 days	4 oz[7]
Method AK101-Liquids	Amber G	4 ± 2 °C, HCl < 2	14 days	3x40 mL
Method AK102-Liquids	Amber G	4 ± 2 °C, HCl or H_2SO_4 to pH < 2	14 days	1000 mL
Method AK102/103-Solids	Amber G	4 ± 2 °C	14 days for extraction 40 days after extraction for analysis	4 oz
MADEP EPH - Liquids	Amber G	4 ± 2 °C, HCl < 2	14 days	4 oz
MADEP EPH – Solids	Amber G	4 ± 2 °C	14 days	1000 mL
MADEP VPH – Liquids (ambient purge) Trip Blank Required	G, teflon-lined septum	4 ± 2 °C, HCl < 2	14 days	3x40 mL
MADEP – VPH Liquids (Heated Purge) Trip Blank Required	G, teflon-lined septum	4 ± 2 °C, Add 0.40 – 0.44g trisodium phosphate dodecahydrate to pH>11	14 days	3x40 mL
MADEP VPH – Solids Trip Blank Required	G, Teflon-lined septum	1mL MeOH/g sample at sampling or within 48 hrs, 4 ± 2 °C	28 days	60mL vials add 25g sample, 40 mL vials add 15 g sample
BTEX – Liquids	G, Teflon-lined septum	0 ≤ 6° C, zero headspace, HCl to pH < 2, 0.008% $Na_2S_2O_3$ [3]	14 days [6]	3x40 mL
BTEX - Solids[8]	**G, Teflon-lined septum**	**0 ≤ 6° C**	**48 hours for preservation and 14 days for analysis**	**3x5 g EnCores or 2 low and 1 high level vials**
Volatiles - Drinking Water	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, HCl to pH < 2	14 days	3x40 mL

Volatiles (including 2 chloroethylvinylether) - Wastewater	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, unpreserved	7 days [6]	3x40 mL
Volatiles - Wastewater/groundwater	G, Teflon-lined cap	0 ≤ 6° C, zero headspace, unpreserved	7 days [6]	3x40 mL
Volatiles - Solids[8]	**EnCore Sampler**	**0 ≤ 6° C**	**48 hours for preservation 14 days for analysis**	**3x5 g EnCores**
Volatiles - Concentrated Waste	G, teflon-lined septum	None	14 days	1x40 mL
Base/Neutral and Acid Extractables and 1,4-Dioxane – Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
Base/Neutral and Acid Extractables and 1,4-Dioxane-Solids[8]	G, Teflon-lined cap	0 ≤ 6° C	14 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
Base/Neutral and Acid Extractables - Concentrated Waste	G, Teflon-lined cap	None	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
TPH-GRO	G, Teflon-lined cap	0 ≤ 6° C, HCl to pH < 2, zero headspace	14 days	3x40 mL
TPH-DRO	G, Teflon-lined cap	0 ≤ 6° C, HCl to pH < 2	14 days	1000 mL / 50 g
Chlorinated Herbicides - Liquids	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	7 days for extraction 40 days after extraction for analysis	1000 mL
Chlorinated Herbicides - Solids[8]	G, Teflon-lined cap	0 ≤ 6° C	14 days for extraction 40 days after extraction	50 g
Organochlorine Pesticides by SW-846 EPA 8081	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
Organochlorine Pesticides by EPA 608 only	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% , $Na_2S_2O_3$ [3], NaOH and H_2SO_4preserve to pH 5.0 to 9.0 (for prep >72 hrs and <7days)	**Unpreserved Prep within 72 hrs** Preserved prep within 7 days 40 days after extraction for analysis	**1000 mL / NA**

PCBs and PCB Congeners	Amber G, Teflon-lined cap	0 ≤ 6° C, 0.008% $Na_2S_2O_3$ [3]	365 days for extraction 365 days after extraction for analysis	1000 mL / 50 g
PCBs in Oil	G, Teflon-lined cap	None	365 days for extraction 365 days after extraction for analysis	1x40 mL
Total Petroleum Hydrocarbon	G, Teflon-lined septum	0 ≤ 6° C	14 days	1000 mL / 50 g
Industrial Solvents	G, Teflon-lined septum	0 ≤ 6° C	14 days	1x40 mL
1,4-Dioxane in Drinking Water by EPA 522	G, Teflon-lined septum	<10°C during transport, Sodium sulfite (50mg/L), sodium bisulfate (1g/L)	28 days for extraction at 0 ≤ 6° C (not frozen) and 28 days after extraction for analysis at -5° C, protected from light	100 mL to 500 mL
Dioxin Screen	G, Teflon-lined cap	0 ≤ 6° C	7 days for extraction 40 days after extraction for analysis	1000 mL / 50 g
EDB and DBCP	G, Teflon-lined septum	0 ≤ 6° C, 0.4% $Na_2S_2O_3$	14 days	3x40 mL / NA
Polynuclear Aromatic Hydrocarbons	Amber G, Teflon-lined septum (Liquids), Teflon-lined cap (Solids)	0 ≤ 6° C	7 days for extraction (Liquids) 14 days to extraction (Solids) 40 days to analysis after extraction	1000 mL / 30 g
Nitroaromatics and Nitroamines	Amber G, Teflon-lined septum	0 ≤ 6° C	7 days for extraction 40 days after extraction for analysis	1000 mL / 2 g
Nitroaromatics and Nitroamines by MIS Prep (solid samples)	Protect from light	0 ≤ 6° C until air drying 22 ± 4° C (or cooler) after drying	14 days for extraction, 40 days after extraction for analysis	Entire Sample

RDX Breakdown	Amber G, Teflon-lined septum for liquids and Teflon-lined cap for solids	0 ≤ 6° C	7 days to extraction for liquids 14 days to extraction for solids 40 days to analysis after extraction	1000 mL / 2 g
Low Level Perchlorate	P	0 ≤ 6° C , headspace required	28 days	10 mL / 2 g
Haloacetic Acids	G, amber, Teflon-lined septum	0 ≤ 6° C , zero headspace, ammonium chloride	14 days to extraction, 7 days after extraction for analysis	3x60 mL
Dissolved Gases	G, Teflon-lined septum	0 ≤ 6° C, HCl to pH < 2, zero headspace	7 days if unpreserved, 14 days if preserved	2x40 mL
Perfluorinated Alkyl Acids	Poly-propylene	0 ≤ 6° C, Trizma® at 5g/L	14 days	250 mL
RADIOCHEMISTRY				
Americium – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Americium – Solids[8]	P,G	None	6 months	20 g
Calcium-45 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	500 mL
Calcium-45 - Solids[8]	P,G	None	6 months	20 g
Carbon-14 Liquids & Solids[8]	P,G	None	6 months	500 mL / 20 g
Cesium 134 – Drinking Water	P,G	HCl to pH < 2	6 months	2000 mL
Chlorine-36 Liquids & Solids[8]	P,G	None	6 months	500 mL / 20 g
Curium - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Curium - Solids[8]	P,G	None	6 months	20 g
Gamma Isotopes - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	2000 mL
Gamma Isotopes - Solids[8]	P,G	None	6 months	200 g
Gross Alpha & Beta – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	500 mL
Gross Alpha & Beta, Rapid - Liquids	**P,G**	**HNO3 or HCl to pH < 2**	**48 – 72 hrs**	**500 mL**
Gross Alpha & Beta - Solids[8]	P,G	None	6 months	20 g
Iodine-129 - Liquids & Solids[8]	P,G	None	6 months	1000 mL / 50 g
Iodine -131 - Liquids	**P,G**	**None**	**8 days**	**1000 mL**

Iron 55 -Liquids	P,G	HNO3 or HCl to pH < 2	6 months	500 mL
Iron 55 - Solids[8]	P,G	None	6 months	20 g
Lead-210 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Lead-210 - Solids[8]	P,G	None	6 months	200 g
Neptunium - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Neptunium - Solids[8]	P,G	None	6 months	20 g
Nickel-59 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Nickel-59 – Solids[8]	P,G	None	6 months	20 g
Nickel-63 - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Nickel-63 - Solids[8]	P,G	None	6 months	20 g
Phosphorus-32 –Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Phosphorus-32 - Solids[8]	P,G	None	6 months	20 g
Plutonium – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Plutonium - Solids[8]	P,G	None	6 months	20 g
Polonium - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Polonium - Solids[8]	P,G	None	6 months	20 g
Promethium-147/Samarium-151 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Promethium-147/Samarium-151 - Solids[8]	P,G	None	6 months	20 g
Radium-223 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	2000 mL
Radium-224 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	2000 mL
Radium-226 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Radium-228 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Radon-222 – Liquids	**G**	**None, Zero headspace**	**4 days**	**2x40 mL**
Selenium-79 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	500 mL
Selenium-79 - Solids[8]	P,G	None	6 months	20 g
Strontium-89/90 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Strontium-89/90 - Solids[8]	P,G	None	6 months	20 g
Sulfur-35 - Liquids	P,G	None	6 months	500 mL
Sulfur-35 - Solids[8]	P,G	None	6 months	20 g
Technetium-99 – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Technetium-99 – Solids[8]	P,G	None	6 months	20 g
Thorium – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL

Thorium - Solids[8]	P,G	None	6 months	20 g
Total Activity Liquids	P,G	HNO3 or HCl to pH < 2	6 months	100 mL
Total Activity - Solids[8]	P,G	None	6 months	20 g
Total Alpha Radium – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	500 mL
Total Alpha Radium - Solids[8]	P,G	None	6 months	20 g
Total Uranium - Liquids	P,G	HNO3 or HCl to pH < 2	6 months	100 mL
Total Uranium - Solids[8]	P,G	None	6 months	20 g
Tritium – Drinking Water	G	None	6 months	250 mL
Tritium – Electrolytic Liquids	P,G	None	6 months	2000 mL
Tritium – Liquids & Solids[8]	P,G	None	6 months	250 mL / 20 g
Uranium – Liquids	P,G	HNO3 or HCl to pH < 2	6 months	1000 mL
Uranium - Solids[8]	P,G	None	6 months	20 g

[1] P = Polyethylene; G = Glass

[2] Samples should be analyzed as soon as possible after collection. The holding times listed are maximum times that samples may be held before analysis and be considered valid.

[3] Used only in the presence of residual chlorine.

[4] Maximum holding time is 24 hours when sulfide is present. All samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If present, remove by adding cadmium nitrate powder until a negative spot test is obtained. Filter sample and add NaOH to pH 12.

[5] Minimum amount of sample needed to prepare and analyze for the parameter. Some parameters may be combined into one analysis, others may need additional amount if quality control is being requested for site-specific samples. Please check with GELs Project Manager for proper sample amounts based on project specific requirements.

[6] Volatiles Groundwater/Wastewater: If samples are to be analyzed for vinyl chloride, styrene, or 2-chloroethylvinyl ether for soil or water, separate samples must be collected without acid preservation and analyzed within 7 days. For aqueous samples to be analyzed for acrolein and acrylonitrile, by EPA Method 624, the samples should be analyzed within 3 days.

[7] Solids Method AK101 2-4 oz amber wide-mouth jars tared and labeled, 1-4 oz amber wide-mouth jar labeled (evaporative loss), 2-25 mL 2.5 ppm surrogated P/T methanol tubes.

[8] Solids matrix typically applies to soils, sludges and sediments. Some tests have been developed for filters, miscellaneous solid waste, plant and animal tissue, also referred to as solids. Contact GEL to verify a particular matrix for the test of interest.

[9] 1mL of 2.5% EDTA solution per 100mL sample

APPENDIX K: STATE SPECIFIC REPORTING CRITERIA

Massachusetts: Drinking Water (Only)

Regulations at 310 CMR 42.13 (5) require that a laboratory have current knowledge of all Federal and Massachusetts standards for all categories in which it has been certified. Within 24 hours of obtaining valid data, a certified laboratory must notify its clients for any results exceeding an EPA-or Department-established maximum contaminant level, maximum residual disinfectant level or reportable concentration.

The laboratory must identify, in writing, those samples needing special reports (e.g. MCL exceedance) when the laboratory subcontracts with another laboratory.

Reports for drinking water samples must contain information relating to the maximum contaminant levels for each analyte. 310 CMR 42.13(3) specifies that with exception of reports submitted to the Department in a format approved by the Department, all reports of finished drinking water analyses must indicate the maximum contaminant level for each analyte measured. This can be accomplished in AlphaLIMS through the permit level in client set up. (Project Managers must enter these values). The maximum contaminant levels should be verified prior or sample log-in. **Please check with Quality Assurance Officer to verify that the information is correct.**

The report must identify, analyses for which the laboratory holds Department certification and which it does not. Regulations at 310 CMR 42.13(3) (b-c) require that such a distinction be made and that the laboratory clearly distinguish in the report between those analyses that it conducted in accordance with Department certification standards and those it did not.

Pennsylvania: Drinking Water (Only)

Any individual (laboratory, sample collection/pic-up facility, consultant, PWS, etc.) providing a sample to an accredited laboratory for SDWA compliance testing purposes must ensure that all relevant, and necessary information is provided along with the sample. Since the laboratory that performs the testing is responsible for reporting and making any notifications (such as MCL violations) to the PWS and the Department, the PWS and sample specific information is both relevant and necessary. If a laboratory chooses, or is required, to subcontract testing to another accredited laboratory, § 109.810(b)(1)(ii) requires that the following information MUST be provided to the subcontract laboratory:

- PWSID# and Name of the System
- Sample Location ID#
- Dates and Times of Sample Collection
- Name and Contact Number of the PWS

The testing laboratory may, if it chooses to, relinquish its authority to report the sample results. However, this relinquishment can only be made to another accredited laboratory and must be made in writing as described in § 109.810(c). The other accredited laboratory, to which the reporting and notification responsibilities are delegated, is then responsible for meeting all of the 25 Pa. Code Chapter 109.810 requirements.

Failure of the testing laboratory to provide verbal and written notification to the Public Water Supply ("PWS") or the Department, or both of an MCL violation with the required timeframes:
The Department requires in § 109.810(b)(1) that the testing laboratory **notify the PWS by telephone within 1 hour of the determination** that an MCL violation has occurred for any SDWA compliance testing result that is at or above the listed MCL for that contaminant. Chapter 252, §§ 252.708(a)(2) and (3) outline the allowable time that may elapse between initial acquisition of the sample result and the final "determination" of the sample result. The time of the determination of the final sample result triggers the start of the clock for the allowable timeframes to provide notification to the PWS and the Department. It is of upmost importance that you understand that leaving a message or voicemail is not considered "notification" of an MCL exceedance. Should the testing laboratory be unable to notify the PWS within 1 hour of the determination, the laboratory must **notify the appropriate DEP regional office by telephone within 2 hours of the determination** of the MCL exceedance. Finally, the testing laboratory is responsible for providing written notification to the Department of any MCL exceedance within 24 hours of the determination.

Failure of the testing laboratory to maintain full and complete records documenting the notification made to the PWS or the Department, or both, when an MCL violation occurs:
The accreditation regulations require that an accredited laboratory maintain accurate and complete records that allow historical reconstruction of the activities undertaken in the laboratory. The testing laboratory must maintain documentation outlining the steps taken to meet the requirements of § 109.810(a)(1) and § 252.708(a)(2) and (3), also known as the acquisition of the initial sample results and the final determination of the sample results to determine compliance with the 1-hour or 2-hour notification requirements. Specifically, the testing laboratory must maintain the following:

- Date and Time of the initial acquisition of the sample result
- Date and Time of the determination of the sample result
- Date and Time of the telephone call(s) to the PWS
- Individual at the PWS to whom the notification was made
- Date and Time of the telephone call(s) to the Department, if required
- Individual at the Department to whom the notification was made, if required
- Any other pertinent information that would be necessary to ensure a complete record

If the testing laboratory delegates the reporting and notification responsibility to another accredited laboratory, as allowed by § 109.810(c), both laboratories must maintain the records to document their activities and must ensure that the notifications occur with the required timelines. It is important to note that the **reporting laboratory has 1 hour from the determination of the result made by the testing laboratory** to notify the PWS of the MCL violation. The 1-hour notification cannot be extended due an intermediate notification from a testing laboratory to a reporting laboratory.

Failure of the laboratory to accurately and fully report the subcontracting testing laboratory's results to the PWS:
It is the laboratory's responsibility to report the final test results of any PA-DEP compliance sample accurately, correctly, unambiguously, and with any specific client instructions or regulations. The laboratory is required to ensure that it reports only those test results that are associated with appropriately collected, handled, stored, prepared, and analyzed samples or report the results with appropriate data qualifiers. In some cases, a laboratory that subcontracts the testing to another accredited laboratory may choose to transcribe the accredited

laboratory's results onto its own letterhead/report format. In these cases, the reporting laboratory is responsible for full, accurate, and complete transcription of all sample results; data qualifiers; sample collection, handling, preparation comments; any case narrative or other applicable comment directly to the PWS.

The Department recommends that laboratories provide the testing laboratory's final test report directly to the PWS instead of the transcribing the results. The Department also reminds all laboratories that only results that are associated with acceptable sample collection, storage, handling, preparation, analysis, test conditions, and quality control may be reported to DWELR. A laboratory may request permission to report qualified DW results by using the "Request to Report Qualified DW Results" form and submission instructions. Please note that microbiology test results are handled differently than chemistry results. Once the microbiology samples are accepted and the analysis begins, positive microbiology test results can only be invalidated by the Department regardless of the performance of the QC, instrument test conditions, etc.

Failure to maintain an SOP for reporting PA-DEP SDWA compliance samples that meet the requirements of 25 PA. Code Chapter 109:
The Department requires all laboratories accredited to perform SDWA compliance testing to maintain an SOP that meets the requirements of § 109.810(b)(3)(ii), also known as the "SWDA Reporting SOP." The SWDA Reporting SOP must be established initially upon accreditation and updated annually thereafter. The SOP must include procedures to meet all of the reporting, documentation, notification requirements of § 109.810. At a minimum, the SOP must include:

- The procedure for ensuring that the laboratory obtains and maintains the information regarding the Public Water Supplier, including PWSID#, name of the PWS, contact name and telephone number for the PWS;
- The procedure for ensuring that the laboratory obtains the sample specific information, including sample location, contaminants(s) of interest, date and time of sample collection;
- The procedure for notifications of MCL exceedances, both telephonic and in writing;
- The procedure for documenting the laboratory's activities related to MCL violations and notifications of such violations;
- The procedure for reporting results to DWELR;
- The telephone numbers for each DEP regional office's main number and after hours emergency response telephone number.

The following is an expert from 25 Pa. Code Chapter 109 as it relates to the requirements for accredited laboratories:

25 Pa. Code Chapter 109, § 109.810. Reporting and notification requirements.

(a) Beginning November 13, 2009, a laboratory accredited under Chapter 252 (relating to environmental laboratory accreditation) shall electronically report to the Department on behalf of the public water supplier and in accordance with the reporting requirements under § 109.701(a) (relating to reporting and recordkeeping), the results of test measurements or analyses performed by the laboratory under this chapter using a secure computer application provided by the Department. In the event of a Department computer application failure, the Department will notify the laboratory of an alternate reporting method. In the event that a laboratory is unable to submit data electronically, due to circumstances beyond its control, the laboratory shall notify the Department prior to the applicable reporting deadline. If the Department

determines that the circumstances were beyond the control of the laboratory, the Department will specify a temporary, alternate reporting method the laboratory shall use to meet the reporting deadline.

(1) Unless a different reporting period is specified in this chapter, these results shall be reported within either the first 10 days following the month in which the result is determined or the first 10 days following the end of the required monitoring period as stipulated by the Department, whichever is shorter.

(2) Beginning November 23, 2009, an accredited laboratory and the public water supplier shall be given until the 10th of the following month to review and update submitted data using a secure computer application provided by the Department. Omissions and data errors remaining after the review period shall be considered reporting violations of the public water supplier.

(b) A laboratory accredited under Chapter 252 shall whenever the results of test measurements or analyses performed by the laboratory under this chapter indicate an MCL, MRDL or treatment technique performance requirements under § 109.202 (relating to State MCLs , MRDLs and treatment technique requirements) is exceeded, or an action level under § 109.1102 (a) (relating to lead and copper) is exceeded, or sample result requires the collection of check or confirmation samples under § 109.301 (relating to general monitoring requirements), or a sample collected under Subchapter M (relating to additional requirements for groundwater sources) is *E. Coli*-positive:

(1) Notify the public water supplier by telephone within 1 hour of the laboratory's determination. If the supplier cannot be reached within that time, notify the Department by telephone within 2 hours of the determination. If is necessary for the laboratory to contact the Department after the Department's routine business hours, the laboratory shall contact the appropriate Department's regional office's after-hours emergency response telephone number and provide information regarding the occurrence, the name of contact person and the telephone number where that individual may be reached in the event further information is needed. If the Department's appropriate emergency number cannot be reached, the laboratory shall notify the appropriate Department regional office by telephone within 1 hour of the beginning of the next business day. Each accredited laboratory shall be responsible for the following:

Obtaining and then maintaining the Department's current after-hours emergency response telephone numbers for each applicable regional office.

(i) Establishing or updating a standard operating procedure by November 8, 2002, and at least annually thereafter to provide the information needed to report the occurrences to the Department. The information regarding the public water system must include, but is not limited to, the PWSID number of the system, the system's name, the contaminant involved in the occurrence, the level of the contaminant found, where the sample was collected, the dates and times that the sample was collected and analyzed, the name and identification number of the certified laboratory, the name and telephone number of a contact person at the laboratory and what steps the laboratory took to contact the public water system before calling the Department.

(2) Notify the appropriate Department district office in writing within 24 hours of the determination. For the purpose of determining compliance with this requirement, the postmark, if the notice is mailed, or the date the notice is received by the Department, whichever is earlier, will be used. Upon approval by the Department, the notice may be made electronically to the Department as long as the information is received within the 24-hour deadline.

(c) A laboratory accredited under Chapter 252 shall meet the requirements under subsections (a) and (b), regarding the results of test measurements or analyses performed by the laboratory under this chapter, unless the laboratory assigns in writing the responsibility for reporting and notification to another accredited laboratory.

(d) A laboratory accredited under Chapter 252 shall be responsible for the accurate reporting of data required under the section to the Department.

dhec

Healthy People. Healthy Communities.

S.C. Department of Health and Environmental Control

Environmental Laboratory Certification Program

In accordance with the provisions of Regulation 61-81, entitled "State Environmental Laboratory Certification Regulations"

GEL LABORATORIES LLC
2040 SAVAGE RD
CHARLESTON, SOUTH CAROLINA 29407

is hereby certified to perform analyses as documented on the attached parameter list(s). This certification does not guarantee validity of the data generated, but indicates the laboratory's adherence to prescribed methodology, quality control, records keeping, and reporting procedures. This certificate is the property of S.C. DHEC and must be surrendered upon demand. This certificate is non-transferable and is valid only for the parameters and methodology listed on the attached parameter list(s).

Laboratory Director: CAREY J BOCKLET
Certifying Authority: SC
Date of Issue: March 16, 2017
Date of Expiration: December 26, 2019
Certificate Number: 10120001

Program Manager
Office of Environmental Laboratory Certification

CR-010021 (09/2010)

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

GEL LABORATORIES LLC (Laboratory ID 10120)
Laboratory Director: CAREY J BOCKLET
Certifying Authority: SC
Certificate Number: 10120001

Date of Issue: March 16, 2017
Expiration Date: December 26, 2019

CLEAN WATER ACT

INORGANIC - DEMAND

BIOCHEMICAL OXYGEN DEMAND(BOD)	SM 5210 B-2011	5 DAY DO DEPLETION
CARBONACEOUS BOD	SM 5210 B-2011	5 DAY DO DEPLETION
CHEMICAL OXYGEN DEMAND (COD)	EPA 410.4 (1993)	SPECTROPHOTOMETRIC, MANUAL OR AUTOMATED
CHEMICAL OXYGEN DEMAND (COD)	HACH 8000 (1979)	SPECTROPHOTOMETRIC (MANUAL OR AUTOMATED)
CHEMICAL OXYGEN DEMAND (COD)	SM 5220 D-2011	SPECTROPHOTOMETRIC, MANUAL OR AUTOMATED
DISSOLVED OXYGEN	SM 4500-O G-2011	ELECTRODE
TOTAL ORGANIC CARBON (TOC)	SM 5310 B-2011	HIGH TEMPERATURE COMBUSTION (TOC)

INORGANIC - MINERAL

ACIDITY	SM 2310 B-2011	ELECTROMETRIC OR PHENOLPHTHALEIN ENDPOINT
ALKALINITY	SM 2320 B-2011	TITRIMETRIC
CHLORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
FLUORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
HARDNESS, TOTAL (AS CACO3)	SM 2340 B-2011	CALCULATIONS
HARDNESS, TOTAL (AS CACO3)	SM 2340 C-2011	TITRIMETRIC (EDTA)
HYDROGEN-ION CONC. (PH)	SM 4500-H B-2011	ELECTROMETRIC MEASUREMENT
SPECIFIC CONDUCTANCE	EPA 120.1 (1982)	WHEATSTONE BRIDGE
SPECIFIC CONDUCTANCE	SM 2510 B-2011	CONDUCTANCE AT 25 DEGREES C
SULFATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

ADSORBABLE ORGANIC HALIDES (AOX)	EPA 1650C (1997)	ADSORPTION AND COULOMETRIC TITRATION
BROMIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
COLOR	SM 2120 B-2011	VISUAL - PLATINUM COBALT
CYANIDE	EPA 335.4 (1993)	SEMI-AUTOMATED COLORIMETRY
CYANIDE	SM 4500-CN C-2011	MANUAL DISTILLATION WITH MGCL2
CYANIDE	SM 4500-CN E-2011	SPECTROPHOTOMETRIC (MANUAL)
CYANIDE AMEN. TO CHLORINATION	SM 4500-CN G-2011	AMENABLE TO CHLORINATION (AFTER DISTILLATION)
OIL & GREASE	EPA 1664B (2010)	OIL & GREASE - HEM/SGT-HEM
PHENOLICS, TOTAL RECOVERABLE	EPA 420.4 (1993)	AUTOMATED COLORIMETRIC (4AAP)
RESIDUAL CHLORINE	SM 4500-CL G-2011	DPD COLORIMETRIC METHOD
SULFIDE	SM 4500-S2 B-2011	SEPARATION OF SOLUBLE AND INSOLUBLE SULFIDES
SULFIDE	SM 4500-S2 D-2011	COLORIMETRIC (METHYLENE BLUE)
SULFITE	SM 4500-SO3 B-2011	TITRIMETRIC (IODINE-IODATE)
SURFACTANTS (MBAS)	SM 5540 C-2011	COLORIMETRIC (METHYLENE BLUE)
TEMPERATURE	SM 2550 B-2010	THERMOMETRIC
TURBIDITY	EPA 180.1 (1993)	NEPHELOMETRIC
TURBIDITY	SM 2130 B-2011	NEPHELOMETRIC

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INORGANIC - NUTRIENT

AMMONIA-NITROGEN	EPA 350.1 (1993)	MANUAL DISTILLATION WITH AUTOMATED PHENATE
AMMONIA-NITROGEN	SM 4500-NH3 B-2011	DISTILLATION
AMMONIA-NITROGEN	SM 4500-NH3 H-2011	AUTOMATED PHENATE
KJELDAHL-NITROGEN	EPA 351.2 (1993)	SEMI-AUTOMATED BLOCK DIGESTER COLORIMETRIC
KJELDAHL-NITROGEN	SM 4500-NORG D-2011	SEMI-AUTOMATED BLOCK DIGESTOR COLORIMETRIC
NITRATE-NITRITE (N02&N03)	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRATE-NITRITE (N02&N03)	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITRITE (N02&N03)	SM 4500-NO3 F-2011	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
ORTHOPHOSPHATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
PHOSPHORUS	EPA 365.4 (1974)	SEMI-AUTOMATED BLOCK DIGESTOR
TOTAL ORGANIC NITROGEN	EPA TKN-NH3-N	TOTAL KJELDAHL-N MINUS AMMONIA-N

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540 C-2011	GRAVIMETRIC (180)
RESIDUE, NONFILTERABLE (TSS)	SM 2540 D-2011	GRAVIMETRIC 103-105
RESIDUE, SETTLEABLE (SS)	SM 2540 F-2011	VOLUMETRIC (IMHOFF CONE) OR GRAVIMETRIC
RESIDUE, TOTAL (TS)	SM 2540 B-2011	GRAVIMETRIC 103-105
RESIDUE, VOLATILE (VS)	EPA 160.4 (1979)	GRAVIMETRIC (550)
RESIDUE, VOLATILE (VS)	SM 2540 E-2011	GRAVIMETRIC 550
TOTAL, FIXED & VOLATILE SOLIDS	SM 2540G (18TH)	PERCENT SOLIDS FOR BIOSOLIDS

INORGANIC - TRACE METAL

ALUMINUM	EPA 200.7 (1994)	ICP/AES
ALUMINUM	EPA 200.8 (1994)	ICP/MS
ANTIMONY	EPA 200.7 (1994)	ICP/AES
ANTIMONY	EPA 200.8 (1994)	ICP/MS
ARSENIC	EPA 200.7 (1994)	ICP/AES
ARSENIC	EPA 200.8 (1994)	ICP/MS
BARIUM	EPA 200.7 (1994)	ICP/AES
BARIUM	EPA 200.8 (1994)	ICP/MS
BERYLLIUM	EPA 200.7 (1994)	ICP/AES
BERYLLIUM	EPA 200.8 (1994)	ICP/MS
BORON	EPA 200.7 (1994)	ICP/AES
BORON	EPA 200.8 (1994)	ICP/MS
CADMIUM	EPA 200.7 (1994)	ICP/AES
CADMIUM	EPA 200.8 (1994)	ICP/MS

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INORGANIC - TRACE METAL

CALCIUM	EPA 200.7 (1994)	ICP/AES
CALCIUM	EPA 200.8 (1994)	ICP/MS
CHROMIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.8 (1994)	ICP/MS
CHROMIUM, HEXAVALENT	SM 3500-CR B-2011	COLORIMETRIC (DIPHYENYLCARBAZIDE)
COBALT	EPA 200.7 (1994)	ICP/AES
COBALT	EPA 200.8 (1994)	ICP/MS
COPPER	EPA 200.7 (1994)	ICP/AES
COPPER	EPA 200.8 (1994)	ICP/MS
IRON	EPA 200.7 (1994)	ICP/AES
IRON	EPA 200.8 (1994)	ICP/MS
LEAD	EPA 200.7 (1994)	ICP/AES
LEAD	EPA 200.8 (1994)	ICP/MS
MAGNESIUM	EPA 200.7 (1994)	ICP/AES
MAGNESIUM	EPA 200.8 (1994)	ICP/MS
MANGANESE	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.8 (1994)	ICP/MS
MERCURY	EPA 1631E (2002)	PURGE AND TRAP CVAFS
MERCURY	EPA 245.2 (1974)	COLD VAPOR (AUTOMATED)
MOLYBDENUM	EPA 200.7 (1994)	ICP/AES
MOLYBDENUM	EPA 200.8 (1994)	ICP/MS
NICKEL	EPA 200.7 (1994)	ICP/AES
NICKEL	EPA 200.8 (1994)	ICP/MS
PLATINUM	EPA 200.8 (1994)	ICP/MS
POTASSIUM	EPA 200.7 (1994)	ICP/AES
POTASSIUM	EPA 200.8 (1994)	ICP/MS
SELENIUM	EPA 200.7 (1994)	ICP/AES
SELENIUM	EPA 200.8 (1994)	ICP/MS
SILICA, DISSOLVED	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.8 (1994)	ICP/MS
SODIUM	EPA 200.7 (1994)	ICP/AES
SODIUM	EPA 200.8 (1994)	ICP/MS
THALLIUM	EPA 200.7 (1994)	ICP/AES
THALLIUM	EPA 200.8 (1994)	ICP/MS
TIN	EPA 200.7 (1994)	ICP/AES
TIN	EPA 200.8 (1994)	ICP/MS
TITANIUM	EPA 200.7 (1994)	ICP/AES
TITANIUM	EPA 200.8 (1994)	ICP/MS
VANADIUM	EPA 200.7 (1994)	ICP/AES

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

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CLEAN WATER ACT

INORGANIC - TRACE METAL

VANADIUM	EPA 200.8 (1994)	ICP/MS
ZINC	EPA 200.7 (1994)	ICP/AES
ZINC	EPA 200.8 (1994)	ICP/MS

PCBS AND PESTICIDES

ORGANOCHLORINE PEST. & PCBS - GC/ECD	EPA 608 (1984)	

SEMI-VOLATILES

BASE/NEUTRALS AND ACIDS - GC/MS	EPA 625 (1984)	

VOLATILES (VOCS)

PURGEABLES - GC/MS	EPA 624 (1984)	

SAFE DRINKING WATER ACT

DISINFECTION BY-PRODUCTS

BROMIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - DEMAND

TOTAL AND DISSOLVED ORGANIC CARBON	SM 5310 B-2011	HIGH TEMPERATURE COMBUSTION (TOC)

INORGANIC - MINERAL

ALKALINITY	SM 2320 B-2011	TITRIMETRIC
CHLORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
FLUORIDE	EPA 300.0 (1993)	ION CHROMATOGRAPHY
HYDROGEN-ION CONC. (PH)	EPA 150.1 (1983)	ELECTROMETRIC MEASUREMENT
SPECIFIC CONDUCTANCE	SM 2510 B-2011	CONDUCTANCE AT 25 DEGREES C
SULFATE	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

COLOR	SM 2120 B-2011	VISUAL - PLATINUM COBALT
RESIDUAL CHLORINE	SM 4500-CL G-2011	DPD COLORIMETRIC METHOD
TEMPERATURE	SM 2550 B-2010	THERMOMETRIC

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INORGANIC - MISCELLANEOUS

TURBIDITY	EPA 180.1 (1993)	NEPHELOMETRIC
TURBIDITY	SM 2130 B-2011	NEPHELOMETRIC

INORGANIC - NUTRIENT

NITRATE-NITRITE (N02&N03)	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRATE-NITRITE (N02&N03)	EPA 353.2 (1993)	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITRITE (N02&N03)	SM 4500-NO3 F-2011	CADMIUM REDUCTION (AUTOMATED)
NITRATE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 300.0 (1993)	ION CHROMATOGRAPHY

INORGANIC - RADIOLOGICAL

URANIUM	EPA 200.8 (1994)	ICP/MS

INORGANIC - RESIDUE

RESIDUE, FILTERABLE (TDS)	SM 2540 C-2011	GRAVIMETRIC (180)

INORGANIC - TRACE METAL

ALUMINUM	EPA 200.7 (1994)	ICP/AES
ALUMINUM	EPA 200.8 (1994)	ICP/MS
ANTIMONY	EPA 200.8 (1994)	ICP/MS
ARSENIC	EPA 200.8 (1994)	ICP/MS
BARIUM	EPA 200.7 (1994)	ICP/AES
BARIUM	EPA 200.8 (1994)	ICP/MS
BERYLLIUM	EPA 200.7 (1994)	ICP/AES
BERYLLIUM	EPA 200.8 (1994)	ICP/MS
CADMIUM	EPA 200.7 (1994)	ICP/AES
CADMIUM	EPA 200.8 (1994)	ICP/MS
CALCIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.7 (1994)	ICP/AES
CHROMIUM	EPA 200.8 (1994)	ICP/MS
COPPER	EPA 200.7 (1994)	ICP/AES
COPPER	EPA 200.8 (1994)	ICP/MS
IRON	EPA 200.7 (1994)	ICP/AES
LEAD	EPA 200.8 (1994)	ICP/MS
MAGNESIUM	EPA 200.7 (1994)	ICP/AES
MANGANESE	EPA 200.7 (1994)	ICP/AES

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INORGANIC - TRACE METAL

MANGANESE	EPA 200.8 (1994)	ICP/MS
MERCURY	EPA 245.2 (1974)	COLD VAPOR (AUTOMATED)
NICKEL	EPA 200.7 (1994)	ICP/AES
NICKEL	EPA 200.8 (1994)	ICP/MS
SELENIUM	EPA 200.8 (1994)	ICP/MS
SILICA, TOTAL	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.7 (1994)	ICP/AES
SILVER	EPA 200.8 (1994)	ICP/MS
SODIUM	EPA 200.7 (1994)	ICP/AES
THALLIUM	EPA 200.8 (1994)	ICP/MS
ZINC	EPA 200.7 (1994)	ICP/AES
ZINC	EPA 200.8 (1994)	ICP/MS

SYNTHETIC ORGANIC COMPOUNDS (SOCS)

EDB, DBCP AND 1,2,3 TCP BY MICROEXT.-GC	EPA 504.1 (1995)	

SOLID & HAZARDOUS WASTES

HERBICIDES

CHLORINATED HERBICIDES BY GC	EPA 8151A (1996)	

INORGANIC - DEMAND

TOTAL ORGANIC CARBON (TOC)	EPA 9060A (2004)	CARBONACEOUS ANALYZER

INORGANIC - HAZARDOUS WASTE CHARACTERISTICS

CORROSIVITY - TOWARDS STEEL	EPA 1110A (2004)	CORROSIVITY TOWARD STEEL
IGNITABILITY (PENSKY MARTENS)	EPA 1010A (2004)	PENSKY-MARTENS CLOSED-CUP
IGNITABILITY (SETAFLASH)	EPA 1020B (2004)	SETAFLASH CLOSED-CUP
SPLP - BOTTLE EXTRACTION	EPA 1312 (1994)	SYNTHETIC PRECIPITATION LEACHING PROCEDURE
SPLP - ZERO HEADSPACE	EPA 1312 (1994)	SYNTHETIC PRECIPITATION LEACHING PROCEDURE
TCLP - BOTTLE EXTRACTION	EPA 1311 (1992)	TOXICITY CHARACTERISTIC LEACHING PROCEDURE
TCLP - ZERO HEADSPACE	EPA 1311 (1992)	TOXICITY CHARACTERISTIC LEACHING PROCEDURE

INORGANIC - MINERAL

CHLORIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY

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SOLID & HAZARDOUS WASTES

INORGANIC - MINERAL

FLUORIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY
HYDROGEN-ION CONC. (PH)	EPA 9040C (2004)	ELECTROMETRIC
HYDROGEN-ION CONC. (PH) (SOIL & WASTE)	EPA 9045D (2004)	SOIL AND WASTE
SPECIFIC CONDUCTANCE	EPA 9050A (1996)	WHEATSTONE BRIDGE
SULFATE	EPA 9056A (2007)	ION CHROMATOGRAPHY

INORGANIC - MISCELLANEOUS

BOMB PREPARATION METHOD	EPA 5050 (1994)	BOMB PREPARATION METHOD
BROMIDE	EPA 9056A (2007)	ION CHROMATOGRAPHY
CYANIDE	EPA 9012B (2004)	TOTAL AND AMENABLE (COLORIMETRIC, AUTOMATED UV)
CYANIDE AMEN. TO CHLORINATION	EPA 9012B (2004)	TOTAL AND AMENABLE (COLORIMETRIC, AUTOMATED UV)
CYANIDE DISTILLATION	EPA 9010C (2004)	DISTILLATION FOR TOTAL & AMENABLE CYANIDE
CYANIDE EXTRACTION PROCEDURE	EPA 9013A (2014)	EXTRACTION PROCEDURE FOR SOLIDS AND OILS
EXTRACT. ORGANIC HALIDES IN SOLIDS (EOX	EPA 9023 (1996)	EXTRACTRABLE ORGANIC HALIDES IN SOLIDS (EOX)
PAINT FILTER LIQUIDS TEST	EPA 9095B (2004)	FILTRATION
PHENOLICS, TOTAL RECOVERABLE	EPA 9066 (1986)	COLORIMETRIC, AUTOMATED 4AAP WITH DISTILLATION
SULFIDE	EPA 9034 (1996)	TRITRIMETRIC FOR ACID-SOL. & ACID-INSOL. SULFIDES
SULFIDE DISTILLATION	EPA 9030B (1996)	DISTILLATION-ACID SOLUBLE & ACID INSOLUBLE SULFIDE
TOTAL ORGANIC HALIDES (TOX)	EPA 9020B (1994)	MICOULOMETRIC-TITRATION DETECTOR

INORGANIC - NUTRIENT

NITRATE-NITROGEN	EPA 9056A (2007)	ION CHROMATOGRAPHY
NITRITE-NITROGEN	EPA 9056A (2007)	ION CHROMATOGRAPHY
ORTHOPHOSPHATE	EPA 9056A (2007)	ION CHROMATOGRAPHY

INORGANIC - TRACE METAL

ALUMINUM	EPA 6010D (2014)	ICP/AES
ALUMINUM	EPA 6020B (2014)	ICP/MS
ANTIMONY	EPA 6010D (2014)	ICP/AES
ANTIMONY	EPA 6020B (2014)	ICP/MS
ARSENIC	EPA 6010D (2014)	ICP/AES
ARSENIC	EPA 6020B (2014)	ICP/MS
BARIUM	EPA 6010D (2014)	ICP/AES
BARIUM	EPA 6020B (2014)	ICP/MS
BERYLLIUM	EPA 6010D (2014)	ICP/AES
BERYLLIUM	EPA 6020B (2014)	ICP/MS
CADMIUM	EPA 6010D (2014)	ICP/AES

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SOLID & HAZARDOUS WASTES

INORGANIC - TRACE METAL

CADMIUM	EPA 6020B (2014)	ICP/MS
CALCIUM	EPA 6010D (2014)	ICP/AES
CALCIUM	EPA 6020B (2014)	ICP/MS
CHROMIUM	EPA 6010D (2014)	ICP/AES
CHROMIUM	EPA 6020B (2014)	ICP/MS
CHROMIUM, HEXAVALENT	EPA 7196A (1992)	COLORIMETRIC
COBALT	EPA 6010D (2014)	ICP/AES
COBALT	EPA 6020B (2014)	ICP/MS
COPPER	EPA 6010D (2014)	ICP/AES
COPPER	EPA 6020B (2014)	ICP/MS
IRON	EPA 6010D (2014)	ICP/AES
IRON	EPA 6020B (2014)	ICP/MS
LEAD	EPA 6010D (2014)	ICP/AES
LEAD	EPA 6020B (2014)	ICP/MS
MAGNESIUM	EPA 6010D (2014)	ICP/AES
MAGNESIUM	EPA 6020B (2014)	ICP/MS
MANGANESE	EPA 6010D (2014)	ICP/AES
MANGANESE	EPA 6020B (2014)	ICP/MS
MERCURY	EPA 7470A (1994)	COLD VAPOR TECHNIQUE LIQUID
MERCURY	EPA 7471B (2007)	COLD VAPOR TECHNIQUE SOLID
METALS DIGESTION	EPA 3005A (1992)	AQUEOUS ACID DIGESTION TOTAL OR DISSOLVED METALS FLAA OR ICP
METALS DIGESTION	EPA 3010A (1992)	AQUEOUS ACID DIGESTION TOTAL METALS FLAA OR ICP
METALS DIGESTION	EPA 3050B (1996)	SOLID ACID DIGESTION
METALS DIGESTION	EPA 3060A (1996)	ALKALINE DIGESTION HEX CHROM
MOLYBDENUM	EPA 6010D (2014)	ICP/AES
MOLYBDENUM	EPA 6020B (2014)	ICP/MS
NICKEL	EPA 6010D (2014)	ICP/AES
NICKEL	EPA 6020B (2014)	ICP/MS
POTASSIUM	EPA 6010D (2014)	ICP/AES
POTASSIUM	EPA 6020B (2014)	ICP/MS
SELENIUM	EPA 6010D (2014)	ICP/AES
SELENIUM	EPA 6020B (2014)	ICP/MS
SILICA, TOTAL	EPA 6010D (2014)	ICP/AES
SILVER	EPA 6010D (2014)	ICP/AES
SILVER	EPA 6020B (2014)	ICP/MS
SODIUM	EPA 6010D (2014)	ICP/AES
SODIUM	EPA 6020B (2014)	ICP/MS
STRONTIUM	EPA 6010D (2014)	ICP/AES
THALLIUM	EPA 6010D (2014)	ICP/AES
THALLIUM	EPA 6020B (2014)	ICP/MS

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SOLID & HAZARDOUS WASTES

INORGANIC - TRACE METAL

TIN	EPA 6010D (2014)	ICP/AES
TIN	EPA 6020B (2014)	ICP/MS
VANADIUM	EPA 6010D (2014)	ICP/AES
VANADIUM	EPA 6020B (2014)	ICP/MS
ZINC	EPA 6010D (2014)	ICP/AES
ZINC	EPA 6020B (2014)	ICP/MS

PCBS AND PESTICIDES

ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3580A (1992)
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3541 (1994)
ORGANOCHLORINE PESTICIDES BY GC	EPA 8081B (2007)	EPA 3535A (2007)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3580A (1992)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3541 (1994)
POLYCHLORINATED BIPHENYLS BY GC	EPA 8082A (2007)	EPA 3535A (2007)

SEMI-VOLATILES

EDB & DBCP BY MICROEXTRACTION AND GC	EPA 8011 (1992)	
POLYNUCLEAR AROM. HYDROCARBONS BY HPLC	EPA 8310 (1986)	EPA 3580A (1992)
POLYNUCLEAR AROM. HYDROCARBONS BY HPLC	EPA 8310 (1986)	EPA 3550C (2007)
POLYNUCLEAR AROM. HYDROCARBONS BY HPLC	EPA 8310 (1986)	EPA 3510C (1996)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3580A (1992)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3541 (1994)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3510C (1996)
SEMIVOLATILE ORGANICS BY GC/MS	EPA 8270D (2014)	EPA 3550C (2007)
SEMIVOLATILE ORGANICS BY GC/MS (SIM)	EPA 8270D (SIM) (2014)	EPA 3541 (1994)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3541 (1994)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3580A (1992)
TPH - DIESEL RANGE ORGANICS (DRO)	EPA 8015C (DRO) (2007)	EPA 3535A (2007)

VOLATILES (VOCS)

VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 3585 (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 5030B (1996)
VOLATILE ORGANICS BY GC/MS	EPA 8260B (1996)	EPA 5035 (1996)

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----------PCBS AND PESTICIDES----------

EPA 608 (1984)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
GAMMA-BHC (LINDANE)
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)
TOXAPHENE

----------SEMI-VOLATILES----------

EPA 625 (1984)

1,2,4-TRICHLOROBENZENE
2,3-DICHLOROANILINE
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DINITROTOLUENE (2,6-DNT)
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYL-4,6-DINITROPHENOL
2-METHYLPHENOL
2-NITROPHENOL

EPA 625 (1984)

3,3-DICHLOROBENZIDINE
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROPHENOL
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ALPHA-TERPINEOL
ANILINE
ANTHRACENE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL BUTYL PHTHALATE
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
CARBAZOLE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIBENZO(A,H)ANTHRACENE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
INDENO(1,2,3-CD)PYRENE
ISOPHORONE
N-DECANE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-OCTADECANE
NAPHTHALENE
NITROBENZENE (NB)
PENTACHLOROPHENOL

EPA 625 (1984)

PHENANTHRENE
PHENOL
PYRENE
PYRIDINE

----------VOLATILES (VOCS)----------

EPA 624 (1984)

1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3-DICHLOROBENZENE
1,4-DICHLOROBENZENE
2-CHLOROETHYLVINYL ETHER
ACROLEIN
ACRYLONITRILE
BENZENE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CIS-1,3-DICHLOROPROPENE
DICHLORODIFLUOROMETHANE
ETHYLBENZENE
METHYL TERT BUTYL ETHER (MTBE)
METHYLENE CHLORIDE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL CHLORIDE
XYLENE, TOTAL

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EPA 504.1 (1995)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

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SOLID & HAZARDOUS WASTES

----------HERBICIDES----------

EPA 8151A (1996)

2,4,5-T
2,4,5-TP (SILVEX)
2,4-D
2,4-DB
DALAPON
DICAMBA
DICHLORPROP
DINOSEB
MCPA
MCPP
PENTACHLOROPHENOL

----------PCBS AND PESTICIDES----------

EPA 8081B (2007)
EPA 3535A (2007)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B (2007)
EPA 3541 (1994)

4,4'-DDD

EPA 8081B (2007)
EPA 3541 (1994)

4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8081B (2007)
EPA 3580A (1992)

4,4'-DDD
4,4'-DDE
4,4'-DDT
ALDRIN
ALPHA-BHC
ALPHA-CHLORDANE
BETA-BHC
CHLORDANE
DELTA-BHC
DIELDRIN
ENDOSULFAN I
ENDOSULFAN II
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
ENDRIN KETONE
GAMMA-BHC (LINDANE)
GAMMA-CHLORDANE
HEPTACHLOR
HEPTACHLOR EPOXIDE
METHOXYCHLOR
TOXAPHENE

EPA 8082A (2007)
EPA 3535A (2007)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3541 (1994)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

EPA 8082A (2007)
EPA 3580A (1992)

PCB-1016 (AROCLOR-1016)
PCB-1221 (AROCLOR-1221)
PCB-1232 (AROCLOR-1232)
PCB-1242 (AROCLOR-1242)
PCB-1248 (AROCLOR-1248)
PCB-1254 (AROCLOR-1254)
PCB-1260 (AROCLOR-1260)

----------SEMI-VOLATILES----------

EPA 8011 (1992)

1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)

EPA 8015C (DRO) (2007)
EPA 3535A (2007)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO) (2007)
EPA 3541 (1994)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8015C (DRO) (2007)
EPA 3580A (1992)

TPH - HIGH BOIL. PT. (DIESEL)

EPA 8270D (2014)
EPA 3510C (1996)

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE
2-METHYLPHENOL

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
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SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D (2014)
EPA 3510C (1996)

2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE

EPA 8270D (2014)
EPA 3510C (1996)

CHLOROBENZILATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,E)PYRENE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ETHYL METHANESULFONATE
FAMPHUR
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE

EPA 8270D (2014)
EPA 3510C (1996)

PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8270D (2014)
EPA 3541 (1994)

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRICHLOROBENZENE
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-METHYLNAPHTHALENE
2-METHYLPHENOL

EPA 8270D (2014)
EPA 3541 (1994)

2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLPHENOL
3-NITROANILINE
4,4-METHYLENEBIS(2-CHLORO.)
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
5-NITRO-O-TOLUIDINE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CAPROLACTAM
CARBAZOLE
CHLOROBENZILATE
CHRYSENE

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----------SEMI-VOLATILES----------

EPA 8270D (2014)
EPA 3541 (1994)

DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DINOSEB
DIPHENYLAMINE
DISULFOTON
ETHYL METHANESULFONATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOSAFROLE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
P-BENZOQUINONE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN

EPA 8270D (2014)
EPA 3541 (1994)

PHENANTHRENE
PHENOL
PHORATE
PHTHALIC ANHYDRIDE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8270D (2014)
EPA 3550C (2007)

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE
2-METHYLPHENOL
2-NITROANILINE

EPA 8270D (2014)
EPA 3550C (2007)

2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE
CHLOROBENZILATE
CHRYSENE
DI-N-BUTYL PHTHALATE

EPA 8270D (2014)
EPA 3550C (2007)

DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,E)PYRENE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ETHYL METHANESULFONATE
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE
PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL

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SOLID & HAZARDOUS WASTES

----------SEMI-VOLATILES----------

EPA 8270D (2014)
EPA 3550C (2007)

PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8270D (2014)
EPA 3580A (1992)

1,1'-BIPHENYL
1,2,4,5-TETRACHLOROBENZENE
1,2,4-TRICHLOROBENZENE
1,2-DICHLOROBENZENE
1,2-DINITROBENZENE
1,2-DIPHENYLHYDRAZINE
1,3,5-TRINITROBENZENE (1,3,5-TNB)
1,3-DICHLOROBENZENE
1,3-DINITROBENZENE (1,3-DNB)
1,4-DICHLOROBENZENE
1,4-DINITROBENZENE
1,4-NAPHTHOQUINONE
1,4-PHENYLENEDIAMINE
1-NAPHTHYLAMINE
2,3,4,6-TETRACHLOROPHENOL
2,4,5-TRICHLOROPHENOL
2,4,6-TRIBROMOPHENOL
2,4,6-TRICHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2,4-DINITROPHENOL
2,4-DINITROTOLUENE (2,4-DNT)
2,6-DICHLOROPHENOL
2,6-DINITROTOLUENE (2,6-DNT)
2-ACETYLAMINOFLUORENE
2-CHLORONAPHTHALENE
2-CHLOROPHENOL
2-FLUOROBIPHENYL
2-METHYLNAPHTHALENE

EPA 8270D (2014)
EPA 3580A (1992)

2-METHYLPHENOL
2-NAPHTHYLAMINE
2-NITROANILINE
2-NITROPHENOL
2-PICOLINE (2-METHYLPYRIDINE)
3,3-DICHLOROBENZIDINE
3,3-DIMETHYLBENZIDINE
3-METHYLCHOLANTHRENE
3-METHYLPHENOL
3-NITROANILINE
4,6-DINITRO-2-METHYLPHENOL
4-AMINOBIPHENYL
4-BROMOPHENYLPHENYL ETHER
4-CHLORO-3-METHYLPHENOL
4-CHLOROANILINE
4-CHLOROPHENYL PHENYL ETHER
4-METHYLPHENOL
4-NITROANILINE
4-NITROPHENOL
4-NITROQUINOLINE-1-OXIDE
5-NITRO-O-TOLUIDINE
7,12-DIMETHYLBENZ(A)ANTHRACENE
A,A-DIMETHYLPHENETHYLAMINE
ACENAPHTHENE
ACENAPHTHYLENE
ACETOPHENONE
ANILINE
ANTHRACENE
ARAMITE
ATRAZINE
BENZALDEHYDE
BENZIDINE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
BENZOIC ACID
BENZYL ALCOHOL
BIS(2-CHLORO-1-METHYLETHYL)ETHER
BIS(2-CHLOROETHOXY)METHANE
BIS(2-CHLOROETHYL)ETHER
BIS(2-ETHYLHEXYL)PHTHALATE
BUTYL BENZYL PHTHALATE
CARBAZOLE

EPA 8270D (2014)
EPA 3580A (1992)

CHLOROBENZILATE
CHRYSENE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIALLATE
DIBENZO(A,E)PYRENE
DIBENZO(A,H)ANTHRACENE
DIBENZOFURAN
DIETHYL PHTHALATE
DIMETHOATE
DIMETHYL PHTHALATE
DIMETHYLAMINOAZOBENZENE
DIPHENYLAMINE
DISULFOTON
ETHYL METHANESULFONATE
FAMPHUR
FLUORANTHENE
FLUORENE
HEXACHLOROBENZENE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
HEXACHLOROETHANE
HEXACHLOROPHENE
HEXACHLOROPROPENE
INDENO(1,2,3-CD)PYRENE
ISODRIN
ISOPHORONE
ISOSAFROLE
KEPONE
METHAPYRILENE
METHYL METHANESULFONATE
METHYL PARATHION
N-NITROSODI-N-BUTYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIETHYLAMINE
N-NITROSODIMETHYLAMINE
N-NITROSODIPHENYLAMINE
N-NITROSOMETHYLETHYLAMINE
N-NITROSOMORPHOLINE
N-NITROSOPIPERIDINE
N-NITROSOPYRROLIDINE
NAPHTHALENE
NITROBENZENE (NB)
O,O,O-TRIETHYLPHOSPHOROTHIOATE
O-TOLUIDINE

EPA 8270D (2014)
EPA 3580A (1992)

PARATHION
PENTACHLOROBENZENE
PENTACHLORONITROBENZENE
PENTACHLOROPHENOL
PHENACETIN
PHENANTHRENE
PHENOL
PHORATE
PRONAMIDE
PYRENE
PYRIDINE
SAFROLE
TETRAETHYL DITHIOPYROPHOSPHATE
THIONAZIN

EPA 8270D (SIM) (2014)
EPA 3541 (1994)

2-METHYLNAPHTHALENE
ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310 (1986)
EPA 3510C (1996)

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE

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----------SEMI-VOLATILES----------

EPA 8310 (1986)
EPA 3510C (1996)

BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310 (1986)
EPA 3550C (2007)

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE
DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

EPA 8310 (1986)
EPA 3580A (1992)

ACENAPHTHENE
ACENAPHTHYLENE
ANTHRACENE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(G,H,I)PERYLENE
BENZO(K)FLUORANTHENE
CHRYSENE

EPA 8310 (1986)
EPA 3580A (1992)

DIBENZO(A,H)ANTHRACENE
FLUORANTHENE
FLUORENE
INDENO(1,2,3-CD)PYRENE
NAPHTHALENE
PHENANTHRENE
PYRENE

----------VOLATILES (VOCS)----------

EPA 8260B (1996)
EPA 3585 (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE

EPA 8260B (1996)
EPA 3585 (1996)

ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE

EPA 8260B (1996)
EPA 3585 (1996)

PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B (1996)
EPA 5030B (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE
1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL
ENVIRONMENTAL LABORATORY CERTIFICATION PROGRAM

GEL LABORATORIES LLC (Laboratory ID 10120)
Certifying Authority: SC
Certificate Number: 10120001

Date of Issue: March 16, 2017
Expiration Date: December 26, 2019

SOLID & HAZARDOUS WASTES

----------VOLATILES (VOCS)----------

EPA 8260B (1996)
EPA 5030B (1996)

4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE
METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE

EPA 8260B (1996)
EPA 5030B (1996)

METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

EPA 8260B (1996)
EPA 5035 (1996)

1,1,1,2-TETRACHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
1,1,2-TRICHLORO-1,2,2-TRIFLUOROETHANE
1,1,2-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1-DICHLOROETHENE
1,1-DICHLOROPROPENE
1,2,3-TRICHLOROBENZENE
1,2,3-TRICHLOROPROPANE
1,2,4-TRICHLOROBENZENE
1,2,4-TRIMETHYLBENZENE
1,2-DIBROMO-3-CHLOROPROPANE(DBCP)
1,2-DIBROMOETHANE (EDB)
1,2-DICHLOROBENZENE
1,2-DICHLOROETHANE
1,2-DICHLOROPROPANE
1,3,5-TRIMETHYLBENZENE
1,3-DICHLOROBENZENE
1,3-DICHLOROPROPANE

EPA 8260B (1996)
EPA 5035 (1996)

1,4-DICHLOROBENZENE
1,4-DIOXANE
2,2-DICHLOROPROPANE
2-CHLOROETHYLVINYL ETHER
2-CHLOROTOLUENE
2-HEXANONE
2-NITROPROPANE
4-BROMOFLUOROBENZENE
4-CHLOROTOLUENE
4-METHYL-2-PENTANONE
ACETONE
ACETONITRILE
ACROLEIN
ACRYLONITRILE
ALLYL CHLORIDE
BENZENE
BENZYL CHLORIDE
BROMOBENZENE
BROMOCHLOROMETHANE
BROMODICHLOROMETHANE
BROMOFORM
BROMOMETHANE
CARBON DISULFIDE
CARBON TETRACHLORIDE
CHLOROBENZENE
CHLORODIBROMOMETHANE
CHLOROETHANE
CHLOROFORM
CHLOROMETHANE
CHLOROPRENE
CIS-1,2-DICHLOROETHENE
CIS-1,3-DICHLOROPROPENE
CIS-1,4-DICHLORO-2-BUTENE
CYCLOHEXANE
DIBROMOMETHANE
DICHLORODIFLUOROMETHANE
DIETHYL ETHER
ETHYL ACETATE
ETHYL METHACRYLATE
ETHYLBENZENE
HEXACHLOROBUTADIENE
IODOMETHANE
ISOBUTYL ALCOHOL
ISOPROPYLBENZENE
METHACRYLONITRILE

EPA 8260B (1996)
EPA 5035 (1996)

METHYL ACETATE
METHYL ETHYL KETONE (MEK)
METHYL METHACRYLATE
METHYL TERT BUTYL ETHER (MTBE)
METHYLCYCLOHEXANE
METHYLENE CHLORIDE
N-BUTANOL
N-BUTYLBENZENE
N-PROPYLBENZENE
NAPHTHALENE
P-ISOPROPYLTOLUENE
PENTACHLOROETHANE
PROPIONITRILE
SEC-BUTYLBENZENE
STYRENE
TERT-BUTYLBENZENE
TETRACHLOROETHENE
TOLUENE
TRANS-1,2-DICHLOROETHENE
TRANS-1,3-DICHLOROPROPENE
TRANS-1,4-DICHLORO-2-BUTENE
TRICHLOROETHENE
TRICHLOROFLUOROMETHANE
VINYL ACETATE
VINYL CHLORIDE
XYLENE, TOTAL

APPENDIX B

Laboratory Standard Operating Procedures

VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE

STANDARD OPERATING PROCEDURE

FOR

THE ANALYSIS OF POLYCHLORINATED BIPHENYLS BY GC/ECD

(GL-OA-E-040 REVISION 24)

APPLICABLE TO METHODS:
EPA SW-846 Methods 8082, 8082A, 8000C, 8000D
EPA 608.3

PROPRIETARY INFORMATION

GEL

GEL'S
DOCUMENT CONTROL OFFICER
CERTIFIES THIS DOCUMENT TO BE
A TRUE COPY OF THE FULLY
EXECUTED ORIGINAL.

AEJ

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TABLE OF CONTENTS

1.0 STANDARD OPERATING PROCEDURE FOR POLYCHLORINATED BIPHENYLS

2.0 METHOD CODES

2.1 EPA SW-846 Methods 8000D, 8082, and 8082A and EPA Method 608.3

3.0 METHOD OBJECTIVE AND PURPOSE

This is a gas chromatographic procedure for quantitatively determining certain polychlorinated biphenyls (PCBs) as Aroclors or as individual PCB congeners and certain polychlorinated terphenyls (PCTs). Analysis is performed using dual capillary columns and a dual detector GC-ECD. The analytical guidance for the detection and quantitation of the applicable polychlorinated biphenyls has been taken from Methods 8082, 8082A, and 8000D.

4.0 METHOD APPLICABILITY AND METHOD SUMMARY

4.1 The following analytes can be quantitatively determined by this procedure:

Aroclor 1016	Aroclor 1221	Aroclor 1232	Aroclor 5432
Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 5442
Aroclor 1260	Aroclor 1262	Aroclor 1268	Aroclor 5460

PCB Congeners (Refer to Appendix 1)

4.2 This method applies to the following matrices:

4.2.1 Groundwater
4.2.2 Wastewater
4.2.3 Soil
4.2.4 Sludge
4.2.5 Miscellaneous matrices
4.2.6 Oil
4.2.7 Filters/Swipes

4.3 This method summarizes the procedures necessary to analyze a sample extract for polychlorinated biphenyls by gas chromatography.

5.0 METHOD SCOPE AND PERFORMANCE CHARACTERISTICS

5.1 The calibration ranges for Aroclors and congeners are compound specific. The lowest concentration calibration standard is used as the quantitation limit.

5.2 The test concentration ranges are:

5.2.1 The tested concentration ranges for liquid matrices are listed below. Please note that these may change and are listed here for guidance only. These limits include an ideal prep factor and are based on a typical calibration.

Compound	Concentration Range
4-CMX (tetrachlorometaxylene)	0.01 µg/L to 0.4 µg/L
DCB (decachlorobiphenyl)	0.01 µg/L to 0.4 µg/L

Aroclor 1016	0.1 µg/L to 4 µg/L
Aroclor 1221	0.1 µg/L to 4 µg/L
Aroclor 1232	0.1 µg/L to 4 µg/L
Aroclor 1242	0.1 µg/L to 4 µg/L
Aroclor 1248	0.1 µg/L to 4 µg/L
Aroclor 1254	0.1 µg/L to 4 µg/L
Aroclor 1260	0.1 µg/L to 4 µg/L
Aroclor 1262	0.1 µg/L to 4 µg/L
Aroclor 1268	0.1 µg/L to 4 µg/L
Aroclor 5432	0.5 µg/L to 20 µg/L
Aroclor 5442	0.5 µg/L to 20 µg/L
Aroclor 5460	0.5 µg/L to 20 µg/L
Congeners (Refer to Appendix 1)	0.02 µg/L to 0.5 µg/L

5.2.2 The tested concentration ranges for solid matrices are as follows:

Compound	Concentration Range
4-CMX (tetrachlorometaxylene)	0.33 µg/kg to 13.3 µg/kg
DCB (decachlorobiphenyl)	0.33 µg/kg to 13.3 µg/kg
Aroclor 1016	3.3 µg/kg to 133 µg/kg
Aroclor 1221	3.3 µg/kg to 133 µg/kg
Aroclor 1232	3.3 µg/kg to 133 µg/kg
Aroclor 1242	3.3 µg/kg to 133 µg/kg
Aroclor 1248	3.3 µg/kg to 133 µg/kg
Aroclor 1254	3.3 µg/kg to 133 µg/kg
Aroclor 1260	3.3 µg/kg to 133 µg/kg
Aroclor 1262	3.3 µg/kg to 133 µg/kg
Aroclor 1268	3.3 µg/kg to 133 µg/kg
Aroclor 5432	16.7 µg/kg to 667µg/kg
Aroclor 5442	16.7 µg/kg to 667µg/kg
Aroclor 5460	16.7 µg/kg to 667µg/kg
Congeners (Refer to Appendix 1)	0.67 µg/kg to 16.7 µg/kg

5.3 Method Detection Limit (MDL) studies for polychlorinated biphenyls, PCTS and congeners are performed annually.

5.4 Precision is determined by the Relative Percent Difference (RPD) between the Laboratory Control Sample (LCS) and the Laboratory Control Sample Duplicate (LCSD), when required, or the Matrix Spike (MS) and the Matrix Spike Duplicate

(MSD). The RPD is determined through Statistical Process Controls (SPC), which are updated on a semiannual basis.

5.5 Accuracy is determined by the percent recovery on LCSs and MSs and the control ranges are determined through SPC limits that are updated semiannually.

6.0 DEFINITIONS

6.1 Definitions specific to this SOP include:

6.2 Limit of Detection (LOD): The lowest concentration level that can be determined by a single analysis and with a defined level of confidence to be statistically different from a blank. The LOD verification is typically spiked at two times the MDL.

6.3 Limit of Quantitation (LOQ): The lowest level in the calibration curve. With the prep factor applied, the LOQ is referred to as the effective LOQ. The LOQ is equivalent to the PQL and LLOQ.

6.4 Lower Limit of Quantitation (LLOQ): The lowest concentration at which a target analyte can be reliably measured and reported. The LLOQ is the lowest point in the calibration curve and represents a concentration at which both quantitative and qualitative requirements can be consistently demonstrated. The LLOQ is verified quarterly as the LOQ verification. The performed by extracting and analyzing an LCS spiked at the LOQ. The LLOQ verification is carried through the same preparation and analytical procedures as environmental samples and QC. The LLOQ is analyzed on every instrument where data are reported and this is the laboratories normal protocol. Recovery of target analytes in the LLOQ are compared to in-house statistically-derived limits.

6.5 Practical Quantitation Limit (PQL): The lowest level in the calibration curve. With the prep factor applied, the PQL is referred to as the effective PQL. The PQL is equivalent to the LOQ and the LLOQ.

6.6 Relative Standard Error (RSE): Standard Error indicates the extent to which a survey estimate is likely to deviate from the true population and is expressed as a number. The Relative Standard Error (RSE) is the standard error expressed as a fraction of the estimate and is usually displayed as a percentage. The RSE acceptance limit criterion is the same as the RSD limit for average CF or RF in the determinative method.

6.7 Lab-wide used definitions can be found in the GL-QS-B-001 the Quality Assurance Plan.

7.0 REFERENCES

7.1 EPA 608.3 and Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/Chemical Methods, Volume 1 (Part 2 and Part 3) Section B. SW-846, Third Edition. USEPA Office of Solid Waste and Emergency Response, Washington, DC 20460, December 2014.

7.1.1 Method 8082, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography," Revision 0, December 1996.
Method 8082A, "Polychlorinated Biphenyls (PCBs) by Gas Chromatography," Revision 1, February 2007.

7.1.2 Test Methods for Evaluating Solid Waste: Laboratory Manual Physical/Chemical Methods, Volume 1B, SW846 Update V, Revision 4, Method 8000D, July 2014.

7.3 Dept. of Defense (DOD), Dept. of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories DOD QSM Version 5.0, July 2013 and Version 5.1, January 2017; DOE QSAS 3.0, July 2013 and Version 3.1 January 2017.

8.0 INTERFERENCES TO THE METHOD

8.1 Interference by phthalates can pose a major problem in PCB determinations and quantitation. These compounds generally appear in the chromatogram as large late-eluting peaks. Common flexible plastics contain varying amounts of phthalates that are easily extracted or leached from such materials during laboratory operations. Cross contamination of clean glassware routinely occurs when plastics are handled during extraction steps, especially when solvent-wetted surfaces are handled.

8.2 Interference for phthalates can best be minimized by avoiding contact with any plastic materials. Exhaustive cleanup of reagents and glassware may be required to eliminate background phthalate contamination.

8.3 The presence of elemental sulfur will result in broad peaks that interfere with the detection of early-eluting peaks. Sulfur contamination should be expected with sediment samples. Method 3660B is used for sulfur removal. Activated copper powder is used to remove sulfur from sample extracts. Refer to GL-OA-E-045 for Sulfur Cleanup.

8.4 If sample extracts are oily, alumina may be used to remove the oil matrix. A glass wool plug is placed in the bottom of a fused silica pipette and activated alumina is placed on top of the glass wool plug. The sample extract is then introduced into the pipette and allowed to flow through the alumina. A pipette bulb may be used to help gently push the sample through the column. The associated batch QCs are cleaned in the same manner as the sample. The following process is used to prepare alumina for use in this procedure. 400 grams of neutral aluminum oxide are muffled at 550° C for two hours. This process activates the alumina to Brockman Grade I. A minimum of 56 mL of distilled water is added to and evenly mixed with the Grade I alumina to achieve deactivation. A 1660 check standard is passed through the alumina. The recovery is compared to the recovery of a 1660 standard not passed through the alumina. Additional water may be added if the alumina is deemed to be overactive, based on the recovery.

8.5 Single-component pesticides, such as DDT and its analogs, may co-elute with the aroclor peaks. Method 8082A recommends that a DDT standard should be analyzed with each analytical sequence to determine which aroclor peaks may co-elute with the pesticides.

9.0 SAFETY PRECAUTIONS AND HAZARD WARNINGS

9.1 Treat all chemicals and samples as potential health hazards, and limit exposure to these chemicals to the lowest level possible. GEL maintains a current awareness file of OSHA regulations regarding the safe handling of the chemicals in the laboratory as well as a reference file of Material Safety Data Sheets (MSDS). These documents and client sample MSDS forms are maintained in the laboratory.

9.2 Personal protective equipment

9.1.1 Gloves are required when handling the chemicals in this procedure. Nitrile gloves are approved for this procedure.

9.1.2 Laboratory coats and safety glasses should also be worn.

9.3 Prior to handling radioactive samples, analysts must have had radiation safety training and must understand their full responsibilities in radioactive sample handling.

9.4 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

9.5 Never leave gas cylinders unchained or untied, including when they are on the moving carts.

9.6 In the event of an accident or medical emergency, call for help immediately. When time and safety permit, an accident report form should be completed and turned in to the GEL Safety Officer.

9.7 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located throughout the lab. Training is available on the proper operation of this equipment.

10.0 CAUTION WARNINGS

The helium, nitrogen and hydrogen tanks should be replaced when pressure drops to approximately 250 psi. It is recommended that the injection port septum be changed daily.

11.0 APPARATUS AND MATERIALS, REAGENTS, EQUIPMENT AND INSTRUMENTS

11.1 Apparatus and equipment may include:

11.2.1 Volumetric flasks

11.2.2 Pasteur pipettes

11.2.3 Microliter syringes (10, 25, 50, 100, 250, 500, and 1000 µL)

11.2.4 Capillary cleaving tool

11.2.5 2 mL amber and clear autosampler screw-capped vials with Teflon-lined septa or 2 mL amber and clear autosampler crimp top vials with 500 µL inserts.

11.2.6 Supeltex 0.5 and 0.8 mm ferrules (or equivalent)

11.2.7 Glass Y-splitter or stainless steel column connector

11.2 Reagent, chemicals and standards

11.2.1 Solvents:

11.2.1.1 Acetone

11.2.1.2 Hexane

11.2.1.3 Isooctane

11.2.1.4 Toluene (pesticide grade or equivalent)

11.2.2 For chemical standards, refer to Section 15.0

11.3 Instrumentation

11.3.1 GC: Agilent 6890 or Agilent 7890 GC with electronic pressure control and Agilent 7683 or 7693 autosampler

11.3.2 Columns:

Restek Rtx-CLPesticides1

Restek Rtx-CLPesticides2

30 m x 0.32 mm x 0.5 µm

NOTE: The instrumentation and columns listed above are merely the recommended instrumentation and columns for use with the method.

12.0 SAMPLE HANDLING AND PRESERVATION REQUIREMENTS

12.1 Samples must be collected in an amber glass bottle with a Teflon-lined cap. The collection containers are bought precleaned from a certified vendor.

12.2 Method 8082 and 8082A recommend holding times of up to a year for the extraction of PCBs. Analysis should be completed within 40 days of extraction. Samples are protected from light and stored at 0° ≤ 6° C after collection. Once extracted, the extract must be analyzed within forty days. However, during this period of time, the extracts are refrigerated at 0° ≤ 6° C in amber vials with Teflon sealed screw caps. When holding dates are missed, the data are qualified accordingly and the client notified.

13.0 SAMPLE PREPARATION TECHNIQUES

Liquid samples are extracted using method 3535A (solid phase extraction). Solid samples are extracted using method 3541 (automated soxhlet extractions). Oil samples are prepared using method 3580 (waste dilution).

NOTE: It is assumed that material within the sample container is considered "the sample." Removal of any extraneous material (twigs, leaves, large rocks, etc.) must be documented in the case narrative and sample extraction logbook.

14.0 EQUIPMENT AND INSTRUMENT MAINTENANCE

14.1 In order to maintain the gas chromatograph's columns and detectors, the gases should be changed when the tank pressure is below 500 psi. The gas chromatograph's septum in the injection port should be changed daily or as needed. Column maintenance is performed when baseline rise is present or when the column becomes contaminated.

14.2 Routine Maintenance

COMPONENT	DAILY	WEEKLY	MONTHLY	AS NEEDED	ANNUAL
Injector Septum	as needed				
Gases				X	
Column Maintenance				X	
Detector Wipe Test					X
Detector Cleaning				X	

14.3 Non-routine Maintenance

14.3.1 When a check standard fails, the standard is examined for signs of evaporation or degradation. If nothing is found, column maintenance should be performed. Approximately one loop of each column, or two loops of guard column should be cleaved. The instrument is then baked out until an acceptable baseline is obtained. If an acceptable baseline is not obtained, the column is leaking and column maintenance must be performed again.

14.3.2 When contamination occurs, first replace or clean the autosampler syringe. If contamination is still present, column maintenance should be performed. If contamination is still present after column maintenance has been performed and the system has been cleaned thoroughly, replace the column. The column must then be leak checked and baked. The instrument must then be checked to determine if the problem is solved and if the instrument is stable. If not, the in-house service technician is called.

14.4 When maintenance is done on the instrument, it must be recorded in the maintenance logbook. It must be initialed and dated.

15.0 PREPARATION OF STANDARD SOLUTION AND QUALITY CONTROL SAMPLES

15.1 Source Standard Solutions

15.1.1 Source standard solutions are purchased from Restek, o2si, AccuStandard, and other certified vendors. These standards are traceable to National Institution of Standards and Technology (NIST) standards.

The standard is given a unique identifying number for that day and is recorded in AlphaLIMS. This standard expires either six months from the date opened if being used for 608 and one year if being used for 8082, or on the vendor expiration date, whichever comes first. Unopened ampoules containing solutions of organic compounds expire according to the vendor's expiration date.

15.2 For guidance on standard documentation, refer to GL-LB-E-007 for Laboratory Standards Documentation.

15.3 All stock standard solutions expire six months from date prepared/opened if no expiration date is provided by the vendor. All other standard solutions must be replaced after six months.

16.0 INSTRUMENT CALIBRATION

16.1 The instrument should be checked for cleanliness and stability prior to analyzing calibration standards. The standards are loaded onto the autosampler with the lowest standard being analyzed first to prevent carryover.

16.2 An external standard technique is used to calibrate the instrument. Both columns are calibrated. Calibration is obtained by analyzing the standards using the same method used for samples. Each standard must contain the same analytes, but at different concentration levels. The area counts of each peak along with the concentration of that particular analyte can then be used to plot a calibration curve. For multi-component peaks such as PCBs, major peaks are chosen to represent the pattern. PCBs require a minimum of five peaks except Aroclor 1221 that requires a minimum of three peaks for quantitation. The area counts of these peaks are then used to obtain a curve. Note that the same peaks are to be used for each concentration level and that a curve is obtained for each peak. The same peaks used in the calibration of the multi-component compounds must be used in any quantitation associated with that calibration curve. The chosen peaks must be at least 25% of the height of the largest Aroclor peak. The typical calibration range is from 100 ug/L to 4,000 ug/L. See section 5.2.2 for calibration ranges with the typical prep factor applied. The lowest calibration level corresponds to the LLOQ (PQL). The MDL, LOD, and LLOQ (LOQ) are verified quarterly. The MDL verification is spiked at the MDL concentration (approximately one third of the LLOQ). The LOD is spiked at two times the MDL. And the LLOQ is spiked at the lowest calibration level (the PQL). Verification samples are extracted using the same methods and processes used for samples and analyzed on each instrument used for that analysis. Statistical Process Limits (SPC) are calculated for the LLOQ using historical data from the lab and are used to evaluate the LLOQ recoveries.

16.3 The initial calibration consists of two parts.

16.3.1 A standard containing a mixture of Aroclor 1016 and Aroclor 1260 (sometimes referred to as 1660) will include many of the peaks

represented in the other Aroclor mixtures. This standard is used to demonstrate linearity of the detector and that a sample does not contain peaks that represent any one of the Aroclors. It can also be used to determine the concentrations of either Aroclor 1016 or Aroclor 1260, should they be present in the sample. Therefore, an initial five-point calibration is performed using this mixture.

16.3.2 Standards of the other Aroclors are necessary for pattern recognition. These standards are also used to determine a single point calibration factor for each Aroclor, assuming that the Aroclor 1016/1260 has been used for detector response. The standards for these Aroclors should be analyzed before the analysis of any samples and may be analyzed before or after the analysis of the five 1016/1260 standards.

16.3.3 If Aroclors other than 1016/1260 are detected in samples, the instrument must be calibrated for those Aroclors and the samples reanalyzed.

16.3.4 Similarly, when PCTs are calibrated, Aroclor 5460 is calibrated first. The other PCT standards are analyzed for pattern recognition. If the other PCTs are not detected, then calibration is not required. If they are detected, they must be calibrated and samples re-analyzed.

16.4 Calculate the mean calibration factor and the relative standard deviation for each analyte at each standard concentration using the formula below. Both columns must meet all acceptance criteria for each analyte of interest before running samples.

16.4.1 Calculate the calibration factor for each analyte at each concentration as:

$$CF = \frac{\text{Peak Area of the Compound in the Standard}}{\text{Mass of the Compound Injected (in nanograms)}}$$

16.4.2 Calculate the mean calibration factor for each analyte as:

$$\overline{CF} = \frac{\sum_{i=1}^{n} CF_i}{n}$$

Where n is the number of standards analyzed.

16.4.3 Calculate the standard deviation and the RSD of the calibration factor for each analyte as:

$$SD = \sqrt{\frac{\sum_{i=1}^{n} (CF_i - \overline{CF})^2}{n-1}} \qquad RSD = \frac{SD}{\overline{CF}} X\ 100$$

If the percent relative standard deviation (%RSD) of the calibration factor is ≤ 20% over the working range, linearity through the origin can be

assumed, and the mean calibration factor can be used to quantitate sample results. When this is not the case, linearity cannot be assumed and the analyst must use a calibration curve.

16.5 If the analyst chooses to use linear regression, he/she must not force the calibration line through the origin.

16.5.1 Make certain that the instrument response is treated as the dependent variable (y) and the concentration as the independent variable (x). The regression will produce the slope and intercept terms for a linear equation in the form:

$$y = ax + b$$

Where:

y = instrument response

a = slope of line (also called the "coefficient of x")

x = concentration of the calibration standard

b = the intercept

16.5.2 The analyst should not force the line through the origin, but have the intercept calculated from the five data points. Otherwise, the problems noted with the RSD value will occur, i.e., a line through the origin will not meet the QC specifications. In addition, do not include the origin (0, 0) as a sixth calibration point.

16.5.3 The regression calculation will generate a correlation coefficient (R) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, R must be > 0.99. The calculated intercept value needs to be evaluated before reporting sample results. If the system you are using calculates the coefficient of determination (R^2), the value must be $\geq$ 0.99.

16.5.4 A positive value for the intercept indicates that there is some threshold instrument response that is the limiting factor in establishing linearity. A negative intercept value can be transformed into an x-intercept value that represents a threshold concentration, which is the limitation. If the intercept is positive, then, as a general rule, results where the instrument response is less than three times (3x) the intercept value may be unreliable. This will afford some protection against false positive results. If the intercept is negative, results below the concentration of the lowest concentration calibration standard may be unreliable.

16.5.5 In calculating the sample concentrations, the regression equation is rearranged to solve for the concentration (x) as shown below:

$$x = \frac{(y - b)}{a}$$

16.6 A minimum number of five calibration standards is required by the method, except for Aroclor 1221, which may use three.

16.7 Method 8000D outlines two procedure that may be used to determine calibration function acceptability for linear and non-linear curves. The calibration data are refitted back to the calibration model. % Error and Relative Standard Error (RSE) evaluate the difference between the measured amount and the true amount (or concentration). % Error is determined as follows:

$$\%Error = \frac{x_i - x_i'}{x_i} \times 100$$

Where:

x'_i = Measured amount of analyte at calibration level I, in mass or concentration units

x_i = True amount of analyte at calibration level I, in mass or concentration units.

16.8 Percent error between the calculated and expected amounts of an analyte should be ≤30% for all standards and ≤50% for the lowest calibration level.

16.9 Relative Standard Error is calculated as follows:

$$RSE = 100 \times \sqrt{\sum_{i-1}^{n} \left[\frac{x_i' - x_i}{x_i} \right]^2} \Big/ (n - p)$$

Where:

x_i = True amount of analyte in calibration level *i*, in mass or concentration units.

x'_i = Measured amount of analyte in calibration level *i*, in mass or concentration units

p = Number of terms in the fitting equation

(average = 1, linear = 2, quadratic =3, cubic = 4)

n = Number of calibration points

16.10 The RSE acceptance limit criterion is the same as the RSD limit for $\overline{CF}$ or $\overline{RF}$ in the determinative method. If the RSD limit is not defined in the determinative method, the limit should be set at ≤20% for well performing compounds.

16.11 Continuing Calibration

16.11.1 The initial calibration curve must be checked and verified prior to conducting any sample analysis. This is accomplished by analyzing a calibration standard of Aroclor 1016/1260 that is at a concentration near the midpoint concentration for the working range of the GC. The standard

must also be injected at intervals no less than once every twenty samples (after 10 is recommended to minimize the number of samples requiring re-injection when the QC limits are exceeded) and at the end of the analysis sequence. The initial calibration check standard must be a second source standard. It must be obtained from a second supplier. This will determine the validity of the initial calibration on a daily basis. Daily calibration check standards may be from a second source or from the same source as the calibration standards.

16.11.2 Calibration verification for linear calibrations involves calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equation below to calculate % Drift or % Difference.

$$\% \text{ Drift} = \frac{\text{Calculated Concentration - Theoretical Concentration}}{\text{Theoretical concentration}} \text{ X } 100$$

Where the calculated concentration is determined using the calibration factor or response factor from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{\overline{CF} - CF_v}{\overline{CF}} \text{ X } 100$$

Where:

CF_V = response factor from current verification check standard.

If this criterion is exceeded, inspect the gas chromatographic system to determine the cause, and perform whatever maintenance is necessary before verifying calibration and proceeding with sample analysis. If the source of the problem can not be determined after corrective action has been taken, a new five-point calibration will be generated.

16.11.3 Each sample must be bracketed with an acceptable continuing calibration standard. The continuing calibration check standard must pass ± 15% of the true value for methods 8082 and ± 20% for method 8082A and 608.3. When a calibration verification standard fails to meet the QC criteria, all samples that were injected after the last acceptable standard may be re-injected. The South Carolina Department of Health and Environmental Control (DHEC) requires that each peak in a multi-component standard be evaluated individually. Each peak should be evaluated to ensure that the response meets the method required 15% (or 20%) difference for calibration verification. If a bracketing CVS fails with a positive bias and there are no detects in the preceding samples, the data may be reported.

16.11.4 When simultaneous analyses are performed from a single injection, it is not practical to designate one column as the primary and the other as

confirmatory. Since the calibration standards are analyzed on both columns, the results for both columns must meet the calibration acceptance criteria. The laboratory's standard practice is to report the lower column result. In cases where Total Aroclors are reported, one column is selected for reporting.

17.0 INSTRUMENT PERFORMANCE REQUIREMENTS

17.1 Recommended Gas Chromatography Conditions

Detector Temperature: 350° C	Make-up Gas: Nitrogen
Injector Temperature: 250° C	Initial Temperature: 130° C
Column A: Rtx CLPesticides1	Hold = 0 min
Column B: Rtx CLPPesticides2	Ramp = 25° C/min
Column Flow = 5 mL/min	Final Temperature: 320° C
Det. Flow = 30 mL/min	Hold = 0.5 min

NOTE: Slight variations may be needed as column length changes. In addition, please note that other columns and analytical parameters may be used.

17.2 Before samples can be analyzed, the baseline must be stable with little or no background noise. The continuing calibration check standard must pass ± 15% (± 20% for 8082A) of the true value. Please note that SC DHEC requires this criterion be met for each peak in a multi-component analyte.

17.3 After every ten samples, a continuing calibration check standard must be analyzed and be ± 15% (± 20% for 8082A) of the true value. If not, the system must be inspected for malfunctions. All samples must be bracketed by passing check standards. The results from the bracketing standards must meet the calibration criteria as specified above. When a calibration verification standard fails to meet the QC criteria, all samples that were injected after the last standard that last met the QC criteria must be evaluated to prevent mis-quantitations and possible false negative results, and re-injection of the sample extracts may be required. More frequent analysis of standards will minimize the number of sample extracts that would have to be reinjected if the QC limits are violated for the standard analysis. However, if the standard analyzed after a group of samples exhibits a response for an analyte that is above the acceptance limit and the analyte was not detected in the specific samples analyzed during the analytical shift, then the extracts for those samples do not need to be reanalyzed, as the verification standard has demonstrated that the analyte would have been detected were it present. In contrast, if the analyte above the QC criteria was detected in a sample extract, then re-injection is necessary to ensure an accurate quantitation. If an analyte was not detected in a sample and the response is more than 15% (20% for 8082A) below the initial calibration response, then re-injection is necessary to ensure that the detector's response has not deteriorated to the point that the analyte would not have been detected even though it was present (i.e., a false

negative result). If the check standard passes on one column and there are no detects, the data may be reported.

17.4 Sample injections may continue for as long as the calibration verification standards and standards interspersed with the samples meet instrument QC requirements. The sequence ends when the set of samples has been injected or when qualitative QC criteria are exceeded.

18.0 ANALYST AND METHOD VERIFICATION REQUIREMENTS

18.1 To establish that the analyst can perform the procedures in an acceptable manner and that the method generates data of acceptable bias and precision, an Initial Demonstration of Capability (IDOC) is required.

18.1.1 A quality control (QC) check standard must be prepared containing each analyte of interest. It must be prepared from pure standard material or purchased as a certified solution. It must be made from a source independent of that used for calibration.

18.1.2 Four Laboratory Control Samples (LCS) must be prepared and analyzed by the same procedures used to prepare and analyze actual samples.

18.1.3 Calculate the average recovery (X) in µg/L and standard deviation of the recovery (S) in µg/L, for each analyte of interest using the four results.

18.1.4 For each analyte compare S and X with the corresponding acceptance criteria for precision and accuracy, respectively, given in the quality control table at the end of the method. If the S and X for all analytes of interest meet the acceptance criteria, the system's performance is acceptable and analysis of actual samples can begin. If any individual S and X exceeds the precision limits or falls out of the range for accuracy, the system's performance is unacceptable for that analyte and a check standard for that analyte must be prepared and reanalyzed. A copy of these data is kept in a file within the Organics Laboratory area.

18.2 Method detection limits are also determined and documented annually. Precision and accuracy is matrix dependent and are documented by means of a Laboratory Control Sample (LCS) and a Laboratory Control Sample Duplicate (LCS DUP). Refer to Section 5.4 and the GL-LB-E-001 for The Determination of Method Detection Limits.

18.3 Analysts are given Performance Evaluation samples as an ongoing assessment of their ability to perform this procedure.

19.0 ANALYSIS PROCEDURES AND INSTRUMENTAL OPERATION

19.1 Standards, samples, blanks and quality control samples are introduced into the instrument via direct injection. Retention time windows must be centered daily for each analyte. Refer to GL-OA-E-001 for Establishing Retention Time Windows for GC and HPLC Analysis as to when and how often retention time windows should be established.

19.2 Samples are analyzed in a set referred to as analysis sequence or run sequence. The sequence begins with the initial check standards with the representative multi-component standards for pattern recognition followed by the sample extracts. A mid-level calibration check standard must be analyzed after every 10 extracts and at the end of each run sequence. The sequence ends when all extracts have been injected and analyzed.

19.3 The data are entered into the computer and a data report is generated. The sequence file is created by the analyst on the computer. It lists, in order, every injection made by the instrument for a given date. The raw data along with a copy of the run sequence, batch sheet, case narrative, and a copy of the retention time window are maintained together.

19.4 1.0 µL of the extract is injected into the instrument. Please note that other injection volumes are allowed.

19.5 All gas chromatographs are equipped with autosamplers. The digital integrator converts the analog from the instrument to digital information that is processed into a graphic format showing concentration based on peak area.

19.6 The automated sequence is initiated by starting the "run sequence" made in ChemStation, which, in turn, controls the autosampler.

19.7 Samples containing target analyte concentrations that exceed the linear range of the analyte calibration curve must be diluted. The dilution level should be performed to place the highest analyte concentration between the middle and high points of the calibration curve (on column). If a sample is initially diluted and target analytes are not detected and non-target analytes are not interfering with the analysis, the sample must be reanalyzed at a lower dilution. Analysts should be aware that diluting samples will increase the detection limits for undetected analytes. Random dilutions without due cause are not acceptable. Samples should undergo appropriate clean up methods prior to diluting for observed matrix problems.

19.8 An initial five-point calibration curve is performed using a mixture of Aroclor 1016 and Aroclor 1260 for PCB analysis. This standard will include many of the peaks represented in the other Aroclor mixtures. Therefore, this mixture is used to demonstrate linearity of the detector and that a sample does not contain peaks that represent any one of the other Aroclors. As stated in section 7.4.6.1 of SW-846 8082, at least five peaks must be used for each Aroclor in the Aroclor 1016 and Aroclor 1260 mixture. The standard practice is to use five peaks for calibration and quantitation for each Aroclor except Aroclor 1221. Three peaks are used for this Aroclor. For PCT analysis, Aroclor 546C is analyzed to demonstrate linearity and PCT pattern recognition. PCB congeners are single peaks and a standard containing all of them is injected.

19.9 Once the Aroclor pattern has been identified, compare the responses of the peaks chosen in the calibration standards with those observed in the sample extract. The

amount of the Aroclor is calculated using the individual calibration factors for each peak chosen during the multi-point calibration. A concentration is determined for each peak. The Aroclor concentration is then determined by averaging the concentration of each peak. Co-eluting peaks, whether from another Aroclor or non-target interference, may result in a final concentration that is biased high. Analyst experience and judgment are critical in determining the extent of the interference. Every effort is made to provide the most accurate data to the client. If matrix interference or co-elution results in only a minor inflation of peak concentration, the results will be reported. If the inflation is considered significant, then the results will be reported from the second column and qualified as necessary.

19.10 In cases where compound identification or quantitation is precluded due to matrix interference (e.g., broad, rounded peaks, sulfur, or ill-defined baselines are present) on both columns, additional cleanup of the extract may be needed. Weathering of PCBs in the environment and changes resulting from waste treatment processes may alter the Aroclor patterns to the point that the pattern of a specific Aroclor is no longer recognizable. Samples containing more than one Aroclor present similar problems. The analyst must also describe in the case narrative specific problems and actions taken to calculate the sample's concentration.

20.0 CALCULATIONS AND DATA REDUCTION METHODS

20.1 The concentration of each analyte in an extract can be determined by comparing the response obtained from analyzing the extract to the calibration curve. The concentration of a specific analyte is matrix specific and is calculated as follows:

Aqueous Sample

$$Concentration\ (\mu g/L) = \frac{(C)(D)(V_t)}{V_i}$$

Where:

C = Concentration (µg/L) calculated by data system from total area substituted into the linear equation derived from the multilevel calibration

D = Dilution factor, if made prior to analysis. If not, D = 1.

V_t = Total volume of the extract in L

V_i = Initial volume of sample in mL

Nonaqueous Samples

$$Concentration\ (\mu g/kg) = \frac{(C)(D)(V_t)}{W}$$

Where:

C = Concentration (µg/kg) calculated by data system from total area substituted into the linear equation derived from the multilevel calibration

D = Dilution factor, if made prior to analysis. If not, D = 1.

V_t = Total volume of the extract

W = Weight of the sample extracted

21.0 DATA RECORDING

Data are recorded and calculated by Chemstation (or other) data acquisition system. They are stored on a remote server. Data are also entered into AlphaLIMS.

22.0 QUALITY CONTROL REQUIREMENTS

22.1 Before analysis of any quality control samples, the instrument must be calibrated. An outside source initial calibration check standard is analyzed to verify that the curve is linear. This outside source check standard must be analyzed every time a new curve is obtained. This check standard must be within ± 15% (± 20% for 8082A) of the true value. A continuing calibration check standard must be analyzed after every ten to verify that the instrument remained calibrated throughout the run.

22.1.1 A method blank (MB) is used to determine background concentrations of analytes of interest that have the potential to interfere with sample analysis. These blanks are analyzed with every analytical batch that has a maximum number of twenty samples. The criterion for acceptance is that there are no target analytes of interest present above the practical quantitation limit (LLOQ).

22.1.2 If the analyte of interest is present at a concentration between the MDL and LLOQ, all data are qualified with a "B" flag and reported. If the analyte of interest is present at a concentration above the LLOQ and the samples contain the analyte of interest at a concentration of greater than 10 times the concentration found in the blank, the data are qualified with a "B" flag and reported. If the concentration found in the sample is less than 10 times that found in the blank and greater than the LLOQ, the samples must be re-extracted.

22.1.3 A laboratory control sample (LCS) and its duplicate (when requested) are analyzed with every batch. The accuracy and precision of the extraction and analysis are monitored with these samples. LCS and LCSD recovery limits are statistically derived (SPC limits) biannually. For SCDHEC liquid samples, the LCS acceptance criteria of 70 – 130% must be met.

22.1.4 Sample matrix spikes (MS) and sample duplicates (DUP) or sample matrix spike duplicates (MSD) are also used to determine precision and accuracy. As with the LCS, recovery limits are statistically generated biannually.

22.1.5 4-CMX and decachlorobiphenyl surrogates are added to all extracts and standards. Acceptance criteria are based on statistically derived limits and are matrix specific. 4-CMX is added to all congener analyses.

22.1.6 The retention time (RT) window must be established using the continuing calibration check standard over a 72-hour period. Refer to GL-OA-E-001 for Establishing Retention Time Windows for Gas Chromatographic and HPLC Analysis for instructions. In order to report a concentration from the external standard table, the retention time of that particular analyte must be within its established window. If not, the concentration is not reported.

22.2 Nonconformance

22.2.1 When running a calibration curve for more than one analyte at a time, some of the analytes may not meet the acceptance criteria. Additional standards containing the compounds that were not acceptable may be analyzed. If the curve still does not meet the acceptance criteria, maintenance should be performed or a new standard may be needed.

22.2.2 If the percent recovery in the MS or MSD falls outside the established SPC limits for recovery, the analyst should evaluate the LCS recoveries and MB analyses. If the LCS and MB analyses do not indicate a problem with the preparation procedures, the MS recoveries may be attributed to matrix effect. Surrogate recovery data should also be used to evaluate the data. Recoveries of both MS compounds and surrogates that are outside the acceptance limits suggest more pervasive analytical problems than problems with the recoveries of either MS or surrogates alone. Analysts are not required to reanalyze the MS for failing recoveries, however they should seek additional technical support before deciding not to reanalyze MS samples.

22.2.3 If the continuing check standard fails any criteria in section 22.1, the analyst must take action to correct the situation. This may be performing any of the maintenance steps described in Section 14 to get the instrument to meet its daily calibration. If all attempts fail, the analyst must analyze a new series of calibration standards, thus obtaining a new calibration curve.

22.2.4 If a surrogate in a sample falls outside the acceptance limits, the sample should be re-extracted, unless the failure duplicates in an MS, MSD or sample DUP or pesticide fraction extraction and analysis. If the surrogate fails the second time, the failure is attributed to matrix interference and the data from the first extraction are reported. If a surrogate in a sample falls outside the acceptance limit with a negative bias or a surrogate in a sample falls outside the acceptance limit and the sample has a target analytes detected, the sample must be re-extracted, unless the failure duplicates in an MS, MSD or sample DUP. If a surrogate in a sample falls outside the acceptance limit with a positive bias and the sample does not have target analytes detected. The analyst should document it in a

DER and report that data. When a sample or batch is sent back to be re-extracted, and passes, a nonconformance form must be completed. The form describes the reasons for re-extraction. (Refer to GL-QS-E-004 for Documentation of Nonconformance Reporting and Dispositioning and Control of Nonconforming Items.)

22.3 Any positive identification and quantitation of an analyte of interest must be confirmed on a separate column. The confirmation column must meet all quality control acceptances described in the method (calibration, retention times, etc.). Calculate the relative percent difference between the two results using the formula:

$$RPD = \frac{|R_1 - R_2|}{\frac{R_1 + R_2}{2}} \times 100$$

22.3.1 Since the same method criteria specified in Sections 22.1, and instrument calibration specified in Sections 16.1 through 16.6 are applied uniformly to both columns, either column can be selected to serve as the primary or confirmatory column.

22.3.2 If one result is significantly higher (> 40%), check the chromatograms to see if an obviously overlapping peak is causing an erroneously high result. If no anomalies are noted, review the chromatographic conditions. If there is no evidence of chromatographic problems, the lower column result is reported, unless a client specifically requests otherwise.

23.0 DATA REVIEW, VALIDATION AND APPROVAL PROCEDURES

23.1 Upon completion of a batch, the analyst uploads the data. A data report is generated and it is placed in a folder along with the batch and all other raw data (chromatograms). This folder is given to the peer review analyst for reviewing. Data may also be reviewed electronically without printing a hardcopy.

23.2 Levels of review and their responsibilities:

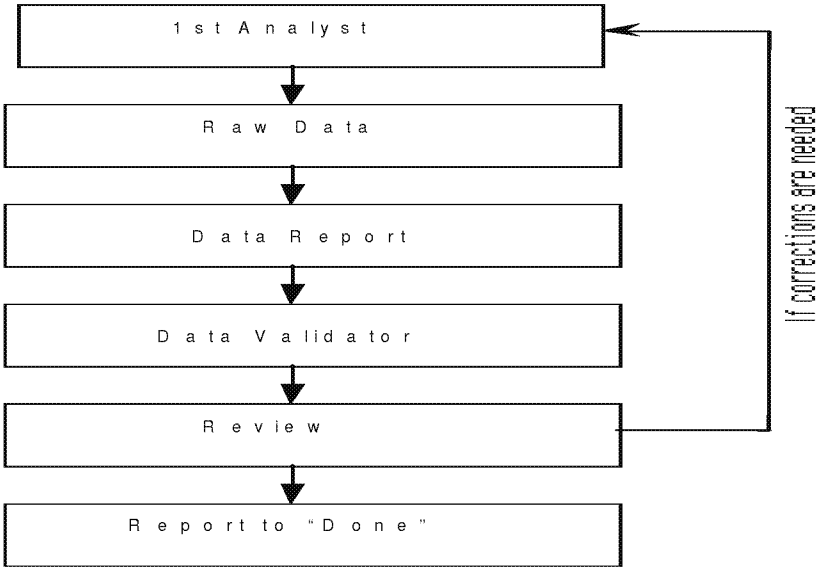
23.2.1 First level review: The analyst must check all chromatograms and will calculate the percent recoveries for the spike, duplicate, and all surrogate recoveries. The analyst must check to see if the check standard passes for the analytes of interest. If a target compound confirms on the conformation column, it must be checked to see if the retention time of the analyte is within the daily retention time window. The peak's shape must also be checked to ensure that it is indeed a peak and not noise. If the hit meets both of these requirements, its concentration should be reported.

23.2.2 Second level review: The data reviewer or other qualified reviewer must ensure that the concentration that appears in the external standards table is indeed what has been entered into the computer. They must check to see if the calibration check standard is acceptable and if the LCS and its

duplicate and the surrogates are all within acceptable ranges. The reviewer must also check the date analyzed, dilution factor, and time of analysis from the raw data against the data report. If everything is acceptable, the reviewer must then initial and date the batch report and the quantitation report, and then complete the checklist to make sure that every item that appears on the review checklist is acceptable. The run log must also be dated and initialed. The data report is then sent to a status of "Done."

23.2.3 To complete a review process, all chromatograms of the calibration check standard, blank, LCS and its duplicate, samples, and the spike and/or duplicates of the sample must be present. The batch sheet, sample tracker log, and the data report should all be present.

23.3 A flow chart of the review process is as follows:



24.0 DATA TRANSMITTAL

After the review process is complete, Data Management receives the data.

25.0 RECORDS MANAGEMENT AND DOCUMENT CONTROL

All data associated with the performance of this procedure, including relevant logbooks, are maintained as quality records in accordance with "Quality Records Management and Disposition" (GL-QS-E-008).

26.0 LABORATORY WASTE HANDLING AND DISPOSAL: SAMPLES, EXTRACTS, DIGESTATES AND REAGENTS

Refer to the "Laboratory Waste Management Plan," (GL-LB-G-001) for the proper handling and disposal of sample waste.

27.0 HISTORY

Revision 19: Updated Appendix 1 on analysis of PCB Congeners.

Revision 20: New compounds added for analysis (PCTs)

Revision 21: Updated to include 8000D and revised reporting column to the lower column result.

Revision 22: Updated References

Revision 23: Updated for implementation of 8000D. Added LLOQ definitions, % Error and Relative Standard Error (RSE)

Revision 24: Updated for clarification of LLOQ definition. Updated Reference Section for DOD/DOE Version 5.1. Updated sections for reference 608 to 608.3.

APPENDIX 1
ANALYSIS OF PCB CONGENERS

PCBs represent a group of 209 individual congeners with varying degrees of toxicity. PCBs are no longer produced in the United States and are no longer used in the manufacture of products. However, small amounts of PCBs may be released into the environment from disposal sites containing transformers, capacitors and other PCB wastes, and from disposing of sediments containing PCBs. This is of particular concern for dredge projects.

While analysis using gas chromatography and high-resolution mass spectroscopy (HR GC/MS) using EPA Method 1668 provides the most definitive identification of all 209 PCB Congeners, Method 8082A (8082B) may also be used for the analysis of various congeners, particularly when cost is a restricting consideration.

The PCB congeners listed below were selected by GEL Laboratories for analysis using Method 8082A (8082B) based on the lists found in the EPA *Evaluation of Dredged Material Proposed for Discharge in Waters of the U.S. – Testing Manual (Inland Testing Manual)* (February 1998) and NOAA guidelines. This list includes those congeners found in the 'summation' and 'highest priority' lists (Table 9-3 of the *Inland Testing Manual*). PCBs have traditionally been quantified with respect to Aroclor mixtures. For dredged material evaluations, the concentration of total PCBs should be determined by summing the concentrations of specific individual PCB congeners. Other congeners may be requested for specific projects and can be added later, provided that all IDOC and quality control criteria are met.

The criteria outlined in this SOP for initial calibrations, initial and continuing calibration verification standards, and quality control samples also apply to congener analyses. Please refer to those sections for acceptance criteria and guidance.

PCB congener samples are extracted and prepped for analysis in the same manner as regular 8082A (8082B) samples using methods 3535A (SPE) and 3541 (automated Soxhlet). Quality control samples include a method blank (MB), laboratory control sample (LCS), laboratory control sample duplicate (LCSD) if appropriate, matrix spike (MS), and matrix spike duplicate (MSD). All samples and QC are spiked with a surrogate standard as well (4-CMX). Note that DCB cannot be used as it is a target analyte.

Congeners 90 and 101 co-elute on the lower column. The concentration of these two analytes is doubled in the calibration table to account for this. For these two congeners, the lab will report results from the front (non-coeluting) column. The lower column result may be reported for the other congeners.

The PCB congener initial calibration is subject to the same acceptance criteria as an 8280A (8082B) calibration (See pertinent sections in this SOP). The typical PCB congener calibration range is from 20 ug/L to 500 ug/L (on-column concentrations). The calibration verification standard (CVS or ICV) is typically made at a concentration of 100 ug/L (on-column concentration). Please note that these ranges reflect conditions at the time of method development and may change over time depending on client and project needs and MDLS and MDLVs would be adjusted accordingly.

APPENDIX 1
ANALYSIS OF PCB CONGENERS (CONT'D)

Analyte	CAS#
BZ# 18 2,2',5-trichlorobiphenyl	37680-65-2
BZ# 8 2,4'-dichlorobiphenyl	34883-43-7
BZ#28 2,4,4'-trichlorobiphenyl	7012-37-5
BZ#170 2,2',3,3',4,4',5-heptachlorobiphenyl	35065-30-6
BZ#180 2,2',3,4,4',5,5'-heptachlorobiphenyl	35065-29-3
BZ#183 2,2',3,4,4',5',6-heptachlorobiphenyl	52663-69-1
BZ#187 2,2',3,4',5,5',6-heptachlorobiphenyl	52663-68-0
BZ#128 2,2',3,3',4,4'-hexachlorobiphenyl	38380-07-3
BZ#138 2,2',3,4,4',5'-hexachlorobiphenyl	35065-28-2
BZ#153 2,2',4,4',5,5'-hexachlorobiphenyl	35065-27-1
BZ#156 2,3,3',4,4',5-hexachlorobiphenyl	38380-08-4
BZ#169 3,3',4,4',5,5'-hexachlorobiphenyl	32774-16-6
BZ#206 2,2',3,3',4,4',5,5',6-nonachlorobiphenyl	40186-72-9
BZ#195 2,2',3,3',4,4',5,6-octachlorobiphenyl	52663-78-2
BZ#101 2,2',4,5,5'-pentachlorobiphenyl	37680-73-2
BZ#105 2,3,3',4,4'-pentachlorobiphenyl	32598-14-4
BZ#118 2,3',4,4',5-pentachlorobiphenyl	31508-00-6
BZ#126 3,3',4,4',5-pentachlorobiphenyl	57465-28-8
BZ#87 2,2',3,4,5'-pentachlorobiphenyl	38380-02-8
BZ#44 2,2',3,5'-tetrachlorobiphenyl	41464-39-5
BZ#49 2,2',4,5'-tetrachlorobiphenyl	41464-40-8
BZ#52 2,2',5,5'-tetrachlorobiphenyl	35693-99-3
BZ#66 2,3',4,4'-tetrachlorobiphenyl	32598-10-0
BZ#77 3,3',4,4'-tetrachlorobiphenyl	32598-13-3
BZ#184 2,2',3,4,4',6,6'-heptachlorobiphenyl	74472-48-3
BZ#90 2,2',3,4',5-pentachlorobiphenyl	68194-07-0
BZ#209 decachlorobiphenyl	2051-24-3

APPENDIX 2: PCB SCREENING PROCEDURE

Overview:

The lab may be asked to screen samples for the presence of PCBs. Screening is particularly useful for determining a baseline concentration of contamination or determining appropriate sample extraction and analysis strategies. It may also be helpful in preventing possible carry-over when samples are analyzed by Method 1668.

This screening appendix is applicable to liquid and solid matrices and primarily focuses on the preparation of samples. The same analytical conditions and calibration criteria outlined in this SOP are used for qualitative and quantitative evaluation of samples. MDLs are not required or performed for screening methods. As a point of clarification, it should be noted that this screening procedure is not the same one used internally by analysts to determine dilutions for Method 8082 analyses.

Quality Control:

A method blank (MB) and laboratory control sample (LCS) are prepared and analyzed with each batch of samples to be screened. In addition, every sample and the MB and LCS are fortified with a surrogate standard prior to extraction and analysis. Static limits are used to evaluate surrogate and LCS recoveries. Samples are not typically re-extracted in the event of failures; however, recovery data provide the end user with an understanding of the accuracy of the screening results.

Liquid Samples:

Typically a 20 mL sample aliquot is placed in a 40 mL vial. A clear vial may be used to aid in visibly discerning layers during sample extraction. The customer may send the 20 mL aliquot in a vial, in which case the lab will perform a visual confirmation of the sample volume. If the lab takes the aliquot, then 20 mL are measured using a disposable pipette. 20 mL of clean DI water are used to prepare the MB and LCS.

A surrogate standard containing Tetrachloro-m-xylene (4CMX) and Decachlorobiphenyl (DCB) is prepared in methanol at a concentration of 20 ng/uL. The MB, LCS, and all samples are spiked with 20 uL of the surrogate standard, resulting in a concentration in the 2 mL prepared extract of 200 ug/L ("on-column" result).

A spiking standard containing Aroclors 1016 and 1260 ("1660") is prepared in methanol at a concentration of 100 ng/uL. The LCS is spiked with 20 uL of the spike standard, resulting in a concentration in the 2 mL prepared extract of 1,000 ug/L ("on-column" result).

Add 2 mL of pesticide grade hexane to each vial. Approximately 7 grams of anhydrous sodium chloride may be added to the vial to aid the extraction efficacy. A color indicator, such as copper sulfate may also be added to aid in discerning the solvent layer from the water. Cap the vials and shake vigorously for at least two minutes, either by hand or on a wrist-action shaker.

APPENDIX 2: PCB SCREENING PROCEDURE (CONTINUED)

Allow the phases to settle. If emulsions develop or the layers do not adequately separate, the vial may be centrifuged for several minutes at 500 G's.

Using a gas tight syringe, transfer the solvent layer to a 2 mL screw cap vial, being careful not to include any water. The sample is now ready to be screened by GC/ECD.

Solid Samples:

For solid samples, typically a 1 gram sample aliquot is taken and placed in a 40 mL vial. A clear vial may be used to aid in visibly discerning layers during sample extraction. The customer may send the 1 gram pre-weighed in a vial. Or, the lab may take an aliquot weighing it on a three place balance. 1 gram of clean Ottawa sand is used to prepare the MB and LCS.

The same surrogate standard used for liquid samples is used with solid samples. The MB, LCS, and all samples are spiked with 50 uL of the surrogate standard, resulting in a concentration in the 2 mL prepared extract of 200 ug/kg ("on-column" result).

The same spiking standard used for liquid samples is used with solid samples. The LCS is spiked with 50 uL of the spike standard, resulting in a concentration in the 2 mL prepared extract of 1,000 ug/kg ("on-column" result).

5 mL of pesticide grade hexane is added to each vial and the same extraction process as above is followed. Note that 2 mL of the extract may be transferred to a 2 mL vial.

Clean-ups:

The analyst may determine that extracts need to be cleaned prior to analysis. Extracts may be cleaned with activated alumina to remove oils and particulates, or copper to remove sulfur.

Screening Limits:

Following the procedures above, the typical reporting limits for screens are 10 ug/L for liquid samples and 500 ug/kg for solid samples. Samples with concentrations of Aroclors below these levels may not be suitable for this screening procedure.

VERIFY THE VALIDITY OF THIS SOP EACH DAY IN USE

STANDARD OPERATING PROCEDURE

FOR

AUTOMATED SOXHLET EXTRACTION

(GL-OA-E-066 REVISON 8)

APPLICABLE TO METHOD:
EPA SW-846 Method 3541

GEL

GEL'S
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CERTIFIES THIS DOCUMENT TO BE
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AEJ

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1.0 STANDARD OPERATING PROCEDURE FOR AUTOMATED SOXHLET EXTRACTION

2.0 METHOD CODE

EPA SW-846 Method 3541

3.0 METHOD OBJECTIVE AND PURPOSE

This procedure describes the extraction of organic analytes from soil, sediment, sludges, and waste solids. In the initial extraction stage, the sample-loaded extraction thimble is immersed in the boiling solvent. This ensures very rapid intimate contact between the sample and solvent and rapid extraction of the organic analytes. In the second stage the thimble is elevated above the solvent, and is rinse-extracted. In the third stage, the solvent is evaporated. The concentrated extract is then ready for cleanup (Method 3600) followed by measurement of the organic analytes.

4.0 SUMMARY OF THE TEST METHOD

1 to 30 grams of moist solid samples (e.g., soil/sediment samples) is chemically dried with anhydrous sodium sulfate. The prepared sample is extracted using 120 mL of solvent in the automated Soxhlet. The extraction is then concentrated, cleaned, if applicable and analyzed.

5.0 METHOD VARIATIONS

The Zymark TurboVap® II and Biotage used in place of the Kuderna-Danish apparatus for the concentration of soil sample extracts.

6.0 INTERFERENCES TO THE METHOD

6.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method for specific guidance on quality control procedures.

6.2 Interferences co-extracted from the samples will vary considerably from source to source. If analysis of an extracted sample is prevented due to interferences, further cleanup of the sample extract may be necessary. Refer to Method 3600 for guidance on cleanup procedures.

6.3 Phthalate esters contaminate many types of products commonly found in the laboratory. Plastics, in particular must be avoided because phthalates are commonly used as plasticizers and are easily extracted from plastic materials. Serious phthalate contamination may result at any time if consistent quality control is not practiced.

6.4 Soap residue (e.g., sodium dodecyl sulfate), which results in a basic pH on glassware surfaces, may cause degradation of certain analytes. Specifically, Aldrin, Heptachlor, and most organophosphorous pesticides will degrade in this situation. This problem is especially pronounced with glassware that may be

difficult to rinse. These items should be hand-rinsed very carefully to avoid this problem.

6.5 The extraction thimble and the o-rings used to seal the extraction cup are both sources of interference. Both should be checked by including a method blank and following the extraction, prior to use, may be necessary to eliminate or reduce interferences. Viton seals contributed least to the interference problem; however, even they contributed some interference peaks when the extraction solvent was analyzed by the electron capture detector. Use of butyl or EPDM rings are not recommended since they were found to contribute significant background when the extraction solvent was 1:1 v/v hexane/acetone or 1:1 v/v methylene chloride/acetone.

7.0 DEFINITIONS

7.1 AlphaLIMS: The Laboratory Information Management System is a computerized database system that records and reports information essential to the quality process of sample analysis.

7.2 Duplicate (DUP): Two aliquots of the same sample analyzed using identical procedures. Analysis of duplicates monitors precision associated with laboratory procedures. Duplicates are done upon customer request.

7.3 Extraction Batch: A group of 20 or fewer samples of similar matrix which are extracted together by the same person/group within the same time period using the same reagents. Each extraction batch will be uniquely identified and include appropriate QC.

7.4 Fractionation Surrogates: Compounds that are added (spiked) to the sample extracts immediately prior to the silica gel fractionation. Used to assess the efficiency of the fractionation process by measuring recovery.

7.5 Laboratory Control Sample (LCS): Reagent grade sand is fortified (spiked) with known quantities of target analytes and subjected to the entire analytical process. The LCS is used to assess the accuracy (recovery) of the method as well as the fractionation efficiency.

7.6 Laboratory Control Sample Duplicate (LCSD): A second LCS that is prepared and extracted in the same manner as the LCS (above). The LCSD is used to assess the accuracy (recovery) and precision of the method as well as the fractionation efficiency.

7.7 Lower Limit of Quantitation (LLOQ): The lowest concentration at which a target analyte can be reliably measured and reported. The LLOQ is ≥ the lowest point in the calibration curve and represents a concentration at which both quantitative and qualitative requirements can be consistently demonstrated. The LLOQ is verified quarterly, as the LOQ verification. The verification is performed by extracting and analyzing an LCS spiked at the lowest level of initial calibration curve (see appropriate analytical SOP for calibration concentration). The LLOQ verification is carried through the same preparation and analytical procedures as

environmental samples and QC. The LLOQ is analyzed on every instrument where data are reported and this is the laboratory's normal protocol. Recovery of target analytes in the LLOQ are compared to in-house-statistically-derived limits. Concentrations in samples reported below the LLOQ and above the MDL are qualified as estimated.

7.8 Matrix: The predominant material of which the sample to be analyzed is composed. For the purpose of this SOP, the sample matrix is soil/sediment. Matrix is not synonymous with phase (liquid or solid).

7.9 Matrix Spike (MS): Aliquot of a matrix fortified (spiked) with known quantities of target analytes and subjected to the entire analytical process. The MS is used to assess the performance of the method for a particular matrix by measuring accuracy (recovery).

7.10 Matrix Spike Duplicate (MSD): A second matrix spike (MS) that is prepared and extracted in the same manner as the MS (above). The MSD is used to assess the performance of the method for a particular matrix by measuring accuracy (recovery) and precision.

7.11 Method Blank: Reagent grade sand that is subjected to the entire analytical process. The method blank is used to assess the level of laboratory background and reagent contamination. At least one method blank per extraction batch will be analyzed.

7.12 Surrogates: Compound(s) added to every blank, LCS, LCSD, sample, MS, and MSD that are used to assess analytical efficiency by measuring recovery. Surrogates are compounds that are not expected to be present in environmental media.

7.13 Refer to GL-QS-B-001 the Quality Assurance Plan for additional lab-wide used definitions,

8.0 SAFETY, HEALTH, AND ENVIRONMENTAL HAZARDS

WARNING

METHYLENE CHLORIDE IS A POSSIBLE CARCINOGEN.

HEXANE IS FLAMMABLE AND TOXIC.

ACETONE IS HIGHLY FLAMMABLE.

WARNING

PREVENT SKIN AND EYE CONTACT BY USING SPECIFIED PERSONAL PROTECTIVE EQUIPMENT WHEN MAKING STOCK REAGENTS.

WORK UNDER A HOOD TO PREVENT INHALATION WHEN MAKING STOCK REAGENTS.

8.1 Wear eye protection with side shields while working in the laboratory.

8.2 All chemicals and samples should be treated as potential health hazards, and exposure to these chemicals must be reduced to the lowest level possible. GEL maintains a current awareness file of Occupational Safety and Health

Administration (OSHA) regulations regarding the safe handling of the chemicals. A reference file of Material Safety Data Sheets (MSDS) and individual client sample MSDSs are also maintained.

8.3 Personal protective equipment

8.3.1 Gloves are required when working with solvents, standards and samples. Solvents, along with any solute in them, can absorb easily through the skin.

8.3.2 Work under a hood when using concentrated acids.

8.3.3 To protect clothes and skin from corrosive material, wear a lab coat.

8.4 Prior to handling radioactive samples analysts must have had radiation safety training and understand their full responsibilities in radioactive sample handling. Some general guidelines to follow:

8.4.1 Wear a dosimeter at all times while working in the lab to monitor radioactive exposure.

8.4.2 Wear a plastic apron over lab coat when working with radioactive samples.

8.4.3 Protect counter tops with counter paper or work from radioactive sample handling trays.

8.4.4 Prohibit admittance to immediate work area.

8.4.5 Post signs indicating radioactive samples are in the area.

8.4.6 Take swipes of the counter tops upon completion of work. Deliver those swipes to the designated swipe count box.

8.4.7 Segregate radioactive wastes. Radioactive waste containers are obtained from Waste Management.

8.5 All samples, chemicals, extracts, and extraction residues must be transferred, delivered, and disposed of safely according to all related SOPs.

8.5.1 Segregate solid wastes from liquid wastes in the satellite area containers.

8.5.2 Segregate oil wastes from water-soluble wastes in the satellite area containers.

8.6 In the event of an accident or medical emergency call for help immediately. When time and safety permit, an accident report form should be completed and turned submitted to the safety committee.

8.7 Fire escape routes are posted in the lab and all personnel should be familiar with them. In addition, fire safety equipment such as fire extinguishers is located in the lab. Training is available on the proper operation of this equipment.

9.0 APPARATUS AND MATERIALS

9.1 Apparatus

9.1.1 Soxtherm Automated Extraction System

9.1.2 Soxtherm Extraction Beakers

9.1.3 Stainless Steel Thimble Rings

9.1.4 Zymark Turbo Vap® II Concentrator

9.1.5 Zymark Tubes

9.2 Materials

9.2.1 Auxiliary Racks

9.2.2 Treated boiling chips: Rinse with methylene chloride three times and place on aluminum foil to dry.

9.2.3 Treated Cellulose Thimble: Heat the thimbles at 135˚ for 2 to 4 hours.

9.2.4 Glass funnels

9.2.5 Filters, ashless circles, 110 mm

9.2.6 Top-Loading Balance, capable of accurately weighing 0.01 grams

9.2.7 2 mL Autosampler vials with Teflon-lined caps

9.2.8 Syringe, 1 to 10mL

9.2.9 Beakers, various sizes as needed.

9.2.10 Vials, glass, various capacities as needed, with Teflon-lined caps.

9.2.11 Disposable pipettes, 1 to 10 mL

9.2.12 Tongue depressors

10.0 REAGENTS AND STANDARDS

10.1 Reagents

10.1.1 Methylene chloride (CH_2Cl_2), pesticide quality or equivalent

10.1.2 Hexane (C_6H_{14}), pesticide quality or equivalent

10.1.3 Acetone (CH_3COCH_3), pesticide quality or equivalent

10.1.4 1:1 Methylene chloride/Acetone: Add 1000 mL methylene chloride to 1000 mL of acetone in 2000 mL flask with tilt.

10.1.5 1:1 Hexane/Acetone: Add 1000 mL of hexane to 1000 mL of acetone in a 2000 mL flask with tilt.

10.1.6 Treated sodium sulfate, granular, anhydrous, ACS grade: Purify by heating at 400° C for 4 hours in a shallow tray, or by pre-cleaning the sodium sulfate with methylene chloride. A method blank must be analyzed, demonstrating that there is no interference from the sodium sulfate.

10.1.7 Reagent grade sand purity by muffling at 400°C for 4 hours in a shallow tray.

10.1.8 A method blank must be analyzed demonstrating that there is no interference from the reagent grade sand.

10.1.9 Nitrogen gas, UHP grade

10.2 Standards

10.2.1 LLOQ standard solutions are purchased directly from a certified vendor or made by diluting the working standards.

11.0 SAMPLE HANDLING AND PRESERVATION

11.1 Sample containers are glass or Teflon with a Teflon-line screw cap. Plastic containers are not used to prevent phthalate or hydrocarbon contamination.

11.2 Protect sample containers from light. Some analytes are light sensitive.

11.3 Samples will be maintained at $0° \leq 6°$ C until extraction begins.

11.4 Samples must be extracted within fourteen days from collection.

11.5 If samples are not in appropriate containers or holding time has expired, initiate a DER. For instructions, refer to GL-QS-E-004.

12.0 SAMPLE PREPARATION

12.1 All Batches (up to 20 samples) will be extracted with a MB, LCS, MS, MSD. If insufficient sample is provided, the MS/MSD will be substituted with a LCS DUP.

12.2 Rinse all glassware with appropriate solvent. Label glassware with the sample number.

12.3 For sediment/soil samples decant and discard any water layer. Homogenize the sample before a representative aliquot is taken. Discard sticks, leaves, rocks, etc. Removal of any extraneous material must be documented in the case narrative and bench logbook.

12.4 Dried sediment/soil and dry waste samples amenable to grinding. Grind or otherwise subdivide the waste so that it either passes through a 1 mm sieve or can be extracted through a 1 mm hole. Introduce sufficient sample into the grinding apparatus to yield at least 20g after grinding.

NOTE: Grinding should only be performed when analyzing for non-volatile organics.

12.5 Gummy, fibrous, oily materials not amenable to grinding should be cut, shredded or otherwise broken up to allow mixing and maximum of the sample surfaces for extraction.

12.6 Add 2 to 3 treated boiling chips and thimble ring to the extraction beaker and rinse thoroughly with extraction solvent.

12.7 Insert a treated thimble by placing in the thimble ring. Label glassware with the sample number.

12.8 Weigh 1 to 30 grams of sample inside of thimble. Record the weight in LIMS.

NOTE: Sample size may be adjusted to meet required detection limits. Sample size may also be adjusted in cases of known or suspended high levels of analyte.

12.9 For paint chip analysis for PCBs. Weigh 1.0g of sample. Record to the nearest 0.1g.

12.10 For swipe analysis, calculations are determined per swipe. Extract the entire swipe.

12.11 Add anhydrous sodium sulfate (Na_2SO_4) granular and mix well to obtain free flowing sample.

NOTE: The spiking and surrogate solutions should be added after the sodium sulfate drying agent to prevent significant recovery issues.

12.12 Add 1 mL appropriate surrogate to all samples and 1 mL of spiking solution to quality control samples. Peer witnessing is practiced during this process.

NOTE: This is for a final volume of 1 mL. (If a different concentration of spiking solution is used, the final volume changes, or the true value changes, adjust solution volume accordingly to determine the new amount of spiking solution to use.)

NOTE: Sample must be free flowing, if not add more treated sodium sulfate.

12.13 Add 120 mL of extraction solvent to the extraction beaker. Add the solvent gently; pouring aggressively may displace the sample from the thimble. Refer to section 22.0 to choose the applicable solvent.

13.0 EXTRACTION PROCEDURE

13.1 Soxtherm Extraction of Solid Samples

13.1.1 Samples are extracted using the Automated Soxhlet Extractor (Soxtherm).

13.1.2 Turn the Soxtherm unit on and verify that the air and water valves are on.

13.1.3 Check the sight glass on the front of the unit to see if the solvent collection tank needs to be drained. When solvent level reaches the bottom of the red mark the collection tank is full. It is good practice to drain the tank before it reaches the bottom of the red mark.

NOTE: Drain in the appropriate waste bottle.

13.1.4 Install the extraction beakers onto the Soxtherm by depressing the holding clamp and carefully sliding the beaker onto the bottom of the Teflon fitting.

13.1.5 Start the automated sequence as follows:

13.1.5.1 Start extraction by pressing "Analysis Start" and then Enter.

13.1.5.2 Select the Soxtherm instruments that will be used for the extractions (U1 through U4).

13.1.5.3 Choose the applicable program then press Enter. Display then asks to confirm program by pressing Enter. Record start time.

NOTE: Refer to Table 1-3 in Section 22.0 for parameters of each program.

13.1.5.4 Press Enter when time and date are displayed. The door of the extractor will close and the extraction beaker will be lowered onto the heating mantle.

NOTE: The soxtherm equipment will give an audio alarm (beeping) if any part of the apparatus requires attention.

13.1.5.5 The extraction is complete when the control box reads "PROGRAM COMPLETE" and the extraction beakers rise off the heating mantle. Record end time.

13.1.5.6 When the extraction beaker has cooled to near room temperature, remove extraction beakers from the soxtherm.

13.1.5.7 If the extract appears to contain water (noticeable droplets or layer on top of the solvent), the following procedure must be used to dry the extract: Otherwise, proceed to section 13.1.5.7.6.

13.1.5.7.1 Add treated sodium sulfate directly to the extract in the extraction beaker. Enough sodium sulfate must be added to cover the bottom of the beaker. Swirl the beaker so that the extract has good contact with the sodium sulfate.

NOTE: Sodium sulfate must be free flowing, if not add more treated sodium sulfate.

13.1.5.7.2 Pour the dried extract in a labeled Zymark tube. Rinse the extraction beaker with 10 to 15 mL of the extraction solvent and add this rinsate to the Zymark tube.

13.1.5.7.3 Alternatively, place a piece of fluted filter paper inside a glass funnel.

13.1.5.7.4 Rinse treated sodium sulfate with the extraction solvent.

13.1.5.7.5 Pour the extract through the packed funnel and collect the dried extract in a labeled Zymark tube The packed funnel must then be rinsed with 10 to 15 mL of the extraction solvent and this rinsate must be collected in the Zymark tube. Proceed to section 13.1.5.7.7.

13.1.5.7.6 Pour the extract in a labeled Zymark tube. Rinse the extraction beaker and thimble with 10-15 mL of the extraction solvent and add this rinsate to the Zymark tube.

13.1.5.7.7 Remove thimble ring and thimble containing spent sample to a hood. Allow thimble and spent sample to air dry. After completely dry, discard the thimble and spent sample in the spent solid waste container.

13.1.5.8 Check that the nitrogen supply to the TurboVap® is turned on.

13.1.5.9 Check the reagent water level in the TurboVap®. It must be at least as high as the inside rack, but not higher than the holes above rack.

13.1.5.10 With the cover closed, turn the unit on and select the pressure mode.

13.1.5.11 Open the lid of the TurboVap® and place the Zymarks in the water bath.

13.1.5.12 Close the cover.

NOTE: During this time extracts need to be checked periodically so that extracts do not go dry. In some cases extracts may need to go longer.

13.1.5.13 Press the cell position START/STOP button. The button's corresponding cell light will come on.

13.1.5.14 Check the gas pressure to verify that the conditions have not changed.

13.1.5.15 For PCBs, concentrate to 1 to 2 mL in Turbo Vap tube and proceed to step 13.1.5.16. For Pesticides, concentrate to 5 mL in Turbo Vap tube and proceed to step 13.1.5.16 if required by client. For BNA and DRO concentrate to 1 mL.

NOTE: Do not allow extract to go below 0.5 mL due to the potential for lower recoveries.

13.1.5.16 Proceed with clean up if necessary. Refer to GL-OA-E-037 for Sulfuric Acid/Permanganate Cleanup of PCB solvent Extract. Refer to GL-OA-E-036 for Florisil Cleanup of Organochlorine Pesticide Solvent Extracts.

13.1.5.17 Transfer to 2 or 4 mL amber vial with Teflon-lined screw cap using a 1 mL disposable pipet. Record final volume. Label wit AlphaLIMS-generate label. Mark the meniscus. All extracts with the exception of those to be analyzed using BNA 8270C and 8270D should be stored at 0 <6 ˚C. The BNA 8270C and 8270D should be stored in a frost-free freezer at less than -10 ˚C.

13.1.5.18 Refer to GL-LB-E-003 for Soxtherm glassware cleanup.

14.0 EQUIPMENT MAINTENANCE

Maintenance to these devices are recorded in LIMS in an electronic logbook .

15.0 PREPARATION OF STANDARD SOLUTIONS AND QUALITY CONTROL SAMPLES

15.1 Source standards are purchased as certified mixtures. Documentation of the standard's quality and traceability should be provided from the vendor. This documentation is submitted to the Quality department. Standards may be purchased from outside vendors, including o2si smart solutions., NSI, Inc.,

AccuStandard, Restek, and Supelco. Other vendors on GEL's Approved Vendors list may also be used.

15.2 Source standards are assigned a unique code number for the purpose of traceability. The standard, along with its code, is recorded in AlphaLIMS. AlphaLIMS can be used to generate a label which is affixed to the standards container, or a handwritten label may be created.

15.3 Stock, intermediate, and working standards are likewise assigned a unique code number and recorded in AlphaLIMS.

NOTE: For recipes, concentrations, analytes and diluents generally used, refer to the Create/Edit/View Reference Materials section of AlphaLIMS.

16.0 QUALITY CONTROL REQUIREMENTS

Typically, a blank, laboratory control sample (LCS), matrix spike (MS), and matrix spike duplicate (MSD) are extracted and analyzed with each prep batch. However, this may vary depending on such factors as sample availability and client requirements. Other client requirements may include a laboratory control sample duplicate (LCSD). They are carried through all stages of sample preparation and analysis.

17.0 DATA REVIEW, APPROVAL, AND TRANSMITTAL

A review process is used to insure the quality of the data. Extraction logs are peer reviewed by a second technician or group leader. When the reviewer is satisfied that the data have been entered correctly, a data report is generated from AlphaLIMS. The report along with the batch sheets are copied and submitted to the appropriate analytical area for analysis.

18.0 RECORDS MANAGEMENT

18.1 Documentation of Training

Extraction technicians must be properly trained to perform the contents of this SOP. Personnel will extract four laboratory control samples for each analytical SOP referenced within this SOP as training commences. The documents are maintained as quality documents in the employee's training file.

18.2 Documentation of Extraction

18.2.1 In AlphaLIMS, complete the Sample Tracker Form. Record initial weight of sample, final volume of extract, amount of surrogate and spikes added, and any comments about the extraction process. Also record all reagent lot numbers and note any deviations from this standard operating procedure.

18.2.2 Print a hard copy to submit with the extracts.

18.2.3 Have batch peer reviewed using data review sheet. Note all discrepancies about sample handling and preservation.

18.2.4 All documents are stored in AlphaLIMS.

18.3 Documentation of Standards

Refer to GL-LB-E-007.

19.0 SAFETY AND POLLUTION PREVENTION

Follow all laboratory safety rules for preparation, analysis and handling of the reagents of interest. Reference method SOPs and the GEL safety plan for guidance.

20.0 LABORATORY WASTE HANDLING AND DISPOSAL

For the proper disposal of sample and reagent wastes from this procedure, refer to the Laboratory Waste Management Plan, GL-LB-G-001.

21.0 REFERENCES

21.1 "Test Methods for Evaluation of Solid Wastes, Physical/Chemical Methods", SW-846, Third Edition, Method 3500B, Revision 2, 1996.

21.2 "Test Methods for Evaluation of Solid Wastes, Physical/Chemical Methods", SW-846, Third Edition, Method 3541, Revision 0, 1994.

21.3 Dept. of Defense (DOD), Dept. of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories DOD QSM Version 5.0, July 2013 and Version 5.1, January 2017; DOE QSAS 3.0, July 2013 and Version 3.1 January 2017.

22.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

22.1 BNA/DRO parameters

Table 1 Soxtherm Program 01 Parameters

Parameter	Value or Instrument Setting
Extraction Solvent	1:1 Methylene Chloride/Acetone (1:1v)
Initial Solvent Volume	120 mL
Extraction Temperature	150° C
Hot Extraction	10 minutes
Reduction Pulse	3 s
Evaporation A	4 x interval
Rinse Time	30 minutes
Evaporation B	1 x interval
Evaporation C	1.0 minutes
Run Time	1 hr 01 min

22.2 DRO parameters

The DRO extraction uses the BNA program with methylene chloride only as the extraction solvent.

22.3 PEST parameters

Table 2 Soxtherm Program 02 Parameters

Parameter	Value or Instrument Setting
Extraction Solvent	Hexane/Acetone (1:1v)
Initial Solvent Volume	120 mL
Extraction Temperature	165° C
Hot Extraction	20 minutes
Reduction Pulse	3 s
Evaporation A	3 x interval
Rinse Time	20 minutes
Evaporation B	1 x interval
Evaporation C	0.0 minutes
Run Time	52 min

22.4 PCB parameters

Table 3 Soxtherm Program 03 Parameters

Parameter	Value or Instrument Setting
Extraction Solvent	Hexane
Initial Solvent Volume	120 mL
Extraction Temperature	160° C
Hot Extraction	1 hr
Reduction Pulse	3 s
Evaporation A	3 x interval
Rinse Time	1 hr
Evaporation B	1.0 x interval
Evaporation C	0.0 min
Run Time	2 hr 04 min

23.0 HISTORY

Revision 4: Updates made to materials, sample preparation and extraction procedures to reflect the current process and equipment being used.

Revision 5: Methylene chloride added to materials section. Recording of start time and end time included for automated sequence on extraction procedure.

Revision 6: Updated Section 3.0 to include current apparatus.

Revision 7: Updated Reagents Section to reflect current practices

Revision 8: Added LLOQ in definitions section. Added reference to new DoD/DoE QSM version 5.1, January 2017. Removed reference to obsolete SOP.